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CLUB CHOLLAS OF THE BIG BEND 3.0: REFINING SPECIES CONCEPTS AND DISTRIBUTIONS FOR THE *CORYNOPUNTIA* [*OPUNTIA, GRUSONIA*] *SCHOTTII* COMPLEX OF WESTERN TEXAS VIA NEW CHROMOSOME COUNTS, POLLEN STAINABILITY, AND MORPHOLOGIC DATA

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ABSTRACT

Species-level understanding of the *Corynopuntia schottii* complex (*C. aggeria, C. densispina, C. emoryi, C. grahamii*, and *C. schottii*) within the USA has long been confused and misunderstood. Most recent taxonomic treatments are incomplete and/or inaccurate regarding four of the species (excluding *C. emoryi*). The present study helps clarify all species concepts in the Big Bend region of Texas through 97 chromosome counts, 186 pollen stainability measurements, 272 new voucher specimens, and review of previously existing herbarium specimens. Significant findings include (1) documentation of *C. schottii* as a hexaploid species that occurs from deep South Texas to just west of the Brewster County line and outside of Big Bend National Park, (2) confirmation of the previously reported chromosome numbers for the remaining taxa, despite uncovering widespread meiotic irregularities in *C. grahamii* and extremely plastic morphology of *C. aggeria*, (3) a range of fertility between and even within populations of all species, and (4) chromosomal and morphological evidence of hybridization and introgression in most taxa. Distinguishing characters, keys to the species (for both living and dried material), distribution maps, photographs of each taxon, and corrections to erroneously labeled published photographs are provided. The Big Bend endemic **Corynopuntia densispina** (Ralston & Hilsenb.) J. Fenstermacher, **comb. nov.**, is formally transferred from *Opuntia*/*Grusonia*. Evolutionary origins of the taxa and their larger geographic and evolutionary context (including Mexico and the broader southwestern USA) are discussed and avenues for future research are suggested.

For over 100 years, taxonomic delineations within the Opuntioidiae have been fraught with difficulty in large part due to a high level of interspecific hybridization, extensive vegetative dispersal and reproduction, paucity of taxonomically meaningful morphological characters, and environmentally influenced morphologic variability (Pinkava et al. 1998; Rebman & Pinkava 2001; Powell & Weedin 2004). Several of the most recent authoritative taxonomic treatments involving *Opuntia* [sensu lato] occurring in the USA (e.g., Pinkava 2003; Powell & Weedin 2004; Hunt 2006) include statements to the effect that parts, or even the entirety, of this group is in need of critical study. For example in Texas, Powell and Weedin (2004) recognized 25 "normal" *Opuntia* (s.l.) taxa as occurring in the Trans-Pecos, while suspecting that between 10 and 20 potentially recognizable species were overlooked; they further emphasized that the classification of *Opuntia* (s.l.) into species and varieties "remains little more than a goal for the future."

Several recent molecular studies have attempted to elucidate intrafamilial relationships in Cactaceae (Nyffeler 2002; Wallace & Dickie 2002; Griffith & Porter 2009; Bárcenas et al. 2011; Hernández-Hernández et al. 2011; Majure et al. 2012c); however, definitive clarity at the generic and specific levels still remains elusive. Several recent field studies based on chromosome counts and morphologic observations have revealed new taxa and broadened understanding of taxon concepts

and evolutionary history (Baker et al. 2009; Donati 2010, 2011; Majure & Ribbens 2012; Majure et al. 2012a, 2012b; Baker & Cloud-Hughes 2014; Breslin & Donati 2014; Felger et al. 2014). The resurgence of non-molecular-based research addresses recognized problems implicated in obscuring clarity of opuntioid systematics including inadequate replicative chromosomal sampling, limited in-depth, field-based observations capturing detailed morphologic traits and breeding system data, and limited distributional context of studies (Pinkava et al. 1998; Rebman & Pinkava 2001; Bárcenas 2004; Rebman 2006; Majure & Ribbens 2012; Majure et al. 2012a, 2012b, 2012c; Baker & Cloud-Hughes 2014). The present study adds new, non-molecular insight into intrageneric relationships of the Big Bend Texas area club chollas. Data for the present study were accumulated over 10 years beginning in 2004 via field observations, chromosome counts, pollen stains, review of existing herbarium specimens, and new voucher collections.

Taxonomic History

The specific taxonomic conundrum focused upon here has engaged specialists for over 60 years. Known from the 1950's as the "*Opuntia schottii* complex," (Anthony 1956) the group now comprises five taxa: *Corynopuntia aggeria*, *C. densispina*, *C. emoryi*, *C. grahamii*, and *C. schottii*, all five referred to herein as the *C. schottii* complex (CSC). These five species are part of a larger clade of small-cylindroid cacti that over time have been variously placed in different genera, most recently within *Grusonia* while also giving support for a modified *Corynopuntia* concept (Bárcenas 2015). Several recent studies, including the examination of seed morphology (Stuppy 2002) and molecular analyses (Griffith 2002; Griffith & Porter 2009; Bárcenas et al. 2011; Bárcenas 2015), while lacking repeatable phylogenies for the entire *Cylindropuntia* tribe (sensu Hunt 2006), have shown that within the concept of *Corynopuntia* one subgroup consistently segregates as monophyletic, separate from others that regularly shift affiliations. The subclades involved are most clearly resolved in Griffith (2002). Strict monophyletic interpretation in Griffith (2002) and Stuppy (2002) leads to placing all cylindroid cacti (including *Cylindropuntia*) into *Grusonia*. However, the amalgamation, as Griffith stated, obscures the natural diversity evident in the lineage, leading Griffith to resurrect older generic concepts including *Micropuntia* and *Corynopuntia*, also utilized by Stuppy (2002). Though a perfectly repeatable, monophyletic *Corynopuntia* has yet to be shown, the consistently-segregating subgroup of club chollas includes the Big Bend species and does repeatedly fall within *Corynopuntia*. Applying this generic designation, as opposed to *Grusonia*, would seem to be the most appropriate because the subclade is bound by both morphologic similarity and consistent segregation in genetic analyses (Griffith 2002; Griffith & Porter 2009; Bárcenas et al. 2011; Bárcenas 2015).

The two foundation taxa for the Big Bend club cholla complex, *Corynopuntia* [*Opuntia*] *schottii* and *C. grahamii*, were described by Engelmann (1856, 1859) based on collections made by Wright, Bigelow, and Schott during the 1851-53 U.S. and Mexico Boundary Survey. The western taxon, *C. grahamii*, was initially collected near El Paso and is known from southern New Mexico south along the Rio Grande into Texas's Big Bend (Fig. 1; A). *Corynopuntia* [*Opuntia*] *schottii* was the eastern taxon, the type having been collected near the mouth of the Pecos River in present day Val Verde County, Texas. Its documented range in the USA has been thought to extend from south Texas upriver into the Big Bend region of southern Brewster County (Fig. 1; B). Both taxa have been reported as ranging much further south of the international border than they do north of it (Hernández et al. 2004; SEINET 2014). These two taxa have been variously treated as separate species (Engelmann 1856; Britton & Rose 1919; Schulz & Runyon 1930; Anthony 1956; Weniger 1988; Ralston & Hilsenbeck 1989; Anderson 2001; Pinkava 2003; Hunt 2006), or varieties of *O. schottii* (Benson 1969, 1982; Correll & Johnston 1970; Pinkava et al. 1985; Powell & Weedin 2004; Powell et al. 2008), and not all authors have believed both taxa to occur in the Big Bend (Weniger 1988).

To keen in situ observers (Anthony 1954; Ralston 1987), field characteristics easily distinguish *Corynopuntia schottii* and *C. grahamii*: both taxa have readily disarticulating distal stem segments (joints), but differ in distribution, phenology, joint growth origin, mound habit, and

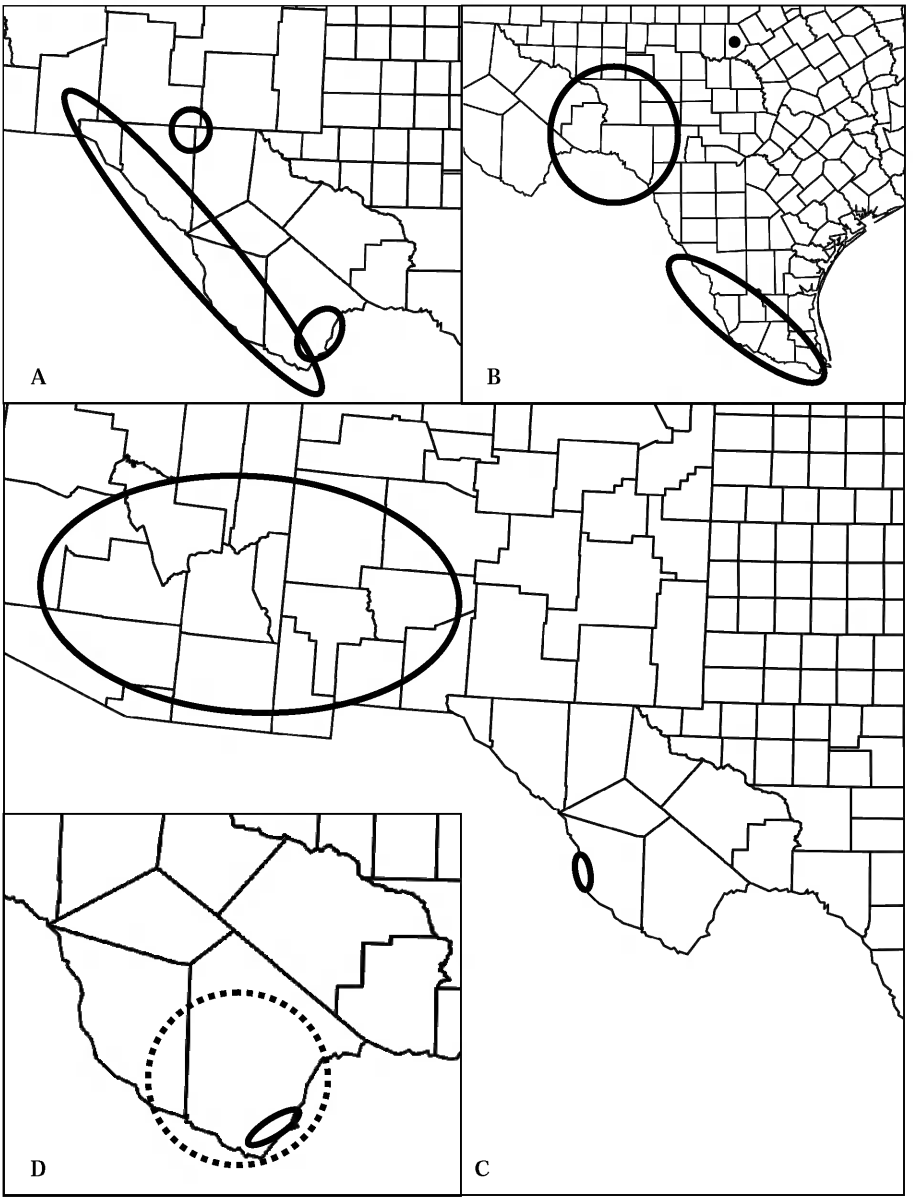

Figure 1. Previously known range extents for the *Corynopuntia schottii* complex in the USA (Texas, New Mexico, Arizona) based on Pinkava (2003) and Powell, Weedin, & Powell (2008). A. *C. grahamii.* B. *C. schottii.* C. *C. emoryi.* D. *C. aggeria*, dotted circle; *C. densispina*, solid oval.

morphology of joints, spines, and roots. Despite these multiple distinctions, the major floristic works involving Big Bend area cacti (Benson 1969; Correll & Johnston 1970; Weniger 1988; Anderson 2001; Pinkava 2003; Powell & Weedin 2004) were inconsistent in their treatments of these taxa, with only one identification guide (Powell et al. 2008) clearly identifying all previously known basic characters enabling definitive identifications of each species in the study area.

The critical key characters of the CSC species may not have been widely apparent to scientists who work, in large part, from dried herbarium specimens. Unfortunately much of the taxonomic effort over the past century likely has been based on poor or incomplete vouchers (i.e., no roots, solitary joints) and/or incomplete label data regarding important field characteristics (e.g., ease of stem disarticulation, growth habit). Additionally, a sufficient breadth of exsiccatae material may also have been lacking. As noted by other specialists (e.g., Rebman & Pinkava 2001; Powell & Weedin 2004; Majure & Ervin 2008), opuntioid species (s.l.) are regularly under-collected in light of their fiberglass-like small spines (glochids), difficulty in processing collections for mounting purposes, and in some species distal joints that easily detach and become embedded in footwear, clothing, and flesh by virtue of their retrorsely-barbed spine tips. Perhaps most confounding is the subfamily's propensity for autogamy plus high frequency of interspecific hybridization, leading to poorly segregated arrays of intermediate morphotypes.

Certainly a major confusing influence concerning CSC species identifications was the regional perception, first discussed by Anthony (1956) then enshrined in Benson (1969), that there was a large area of distributional overlap in Brewster County, Texas, where the two foundation species supposedly freely intergraded. Anthony was the first to work specifically on the Big Bend Opuntiae (Anthony 1949) and as part of her work she proposed a hybrid taxon (Anthony 1956) to account for what was perceived as an apparent abundance of intermediate individuals. This concept lasted throughout the following 20 years until, based both on robust field collections and newly advanced research techniques (i.e., chromosome counts, pollen stainability, phytochemistry), Ralston (1987) determined that the two CSC foundation species were indeed distinct with little evidence of intermediate individuals. Then Ralston and Hilsenbeck (1989) demonstrated that Anthony's "putative hybrid" was actually a distinct, fertile, diploid entity: *Corynopuntia aggeria*. It was described as the predominant club cholla occurring in Big Bend National Park (Fig. 1 C), whereas *C. grahamii* and *C. schottii* were stated to occur there sympatrically with *C. aggeria* but in a limited, undefined area without evidence of intergradation.

Ultimately, Ralston and Hilsenbeck (1992) described another club cholla species from Big Bend National Park, *Corynopuntia densispina*, based on distinct morphology and tetraploid chromosome number. Seemingly restricted to clay substrates in an isolated area just north of the Rio Grande (Fig. 1 C), *C. densispina* was not widely accepted by cactus specialists, who noted undue overlap with the concept of *C. schottii*. The newest species was omitted, placed in synonomy, or simply not mentioned in the majority of subsequent, authoritative floristic treatments and checklists (Anderson 2001; Pinkava 2003; Bárcenas 2004; Hernandez et al. 2004; Hunt 2006).

Separate from the confusion over the two foundation taxa, a third club cholla, *Corynopuntia emoryi*, had been discovered to occur in western Texas in the late 1970s (Weedin & Powell 1978). More commonly known from southeastern Arizona, southern New Mexico, and adjacent Mexico, its small disjunct population in southern Presidio County is just upriver from the core distribution of the other CSC species (Fig 1 D). As a geographically peripheral CSC member, the tetraploid *C. emoryi* has not typically been involved in any of the associated taxonomic problems.

Despite the description of two new species, *Corynopuntia aggeria* and *C. densispina*, taxonomic relationships of the four "core" western Texas club chollas (*C. aggeria, C. densispina, C.*

grahamii, *C. schottii*) remained unclear in many ways: (1) contemporaneous and conflicting labels proliferate on more than a few herbarium sheets of each taxon, (2) published chromosome counts for vouchers identified as *C. schottii* (last summarized in Pinkava 2002) reflect continued disagreement regarding ploidy level (n = 11, 22, 33), (3) identities of chromosomal vouchers for *C. schottii* were considered ambiguous (Powell & Weedin 2004), (4) significant meiotic and pollen stainability irregularities were observed in populations assumed to be *C. schottii* (Ralston 1987; Powell & Weedin 2004), and (5) polyploid chromosome counts were made from populations that appeared morphologically to be *C. aggeria* despite its reportedly diploid nature (Powell & Weedin 2004). Perhaps most tellingly, incorrectly identified photos and specimens, omission of important characters (e.g., ease of disarticulation, chromosome number), and/or inaccurate descriptions have persisted even in recent authoritative literature (Pinkava 2003; Bárcenas 2004; Hunt 2006; SEINET 2014; USDA, NRCS 2014).

The current study aims to clarify species distinctions and relationships within the Big Bend club chollas via chromosomal, pollen stainability, and morphologic data. The long-standing confusion and inconsistent reports regarding species' morphologic characteristics and distributions are addressed, easy to use keys for both field and herbarium use are provided, and the incidence of hybridization between several species, potential novel taxa, and possible mechanisms for evolutionary development are examined. Several avenues showing promise for further investigation are also discussed.

MATERIALS AND METHODS

Chromosome counts. The majority of chromosome numbers were obtained through meiotic observations. Flower buds were removed from the plant and bisected longitudinally to view developing anthers for the appropriate size. If buds encountered were not sufficiently developed to yield the appropriate meiotic stage, the entire joint was harvested with bud still attached, kept indoors in a sunny location, then harvested after a few days of further growth. Immediately upon harvest buds were fixed in modified Carnoy's Solution (4:3:1) generally overnight. Anthers were then removed from buds with forceps and macerated in acetocarmine stain (Turner & Johnston 1961) and observed immediately. All counts were made by the author and/or A. Michael Powell, except for two meiotic and two mitotic counts provided by Marc Baker.

Pollen stainability. Pollen for stainability measurements was collected from either living or dried specimens. Anthers were collected in the field from open flowers, or joints with the most mature buds were harvested and placed in a sunny location until the flowers opened. Recently closed flowers were sampled rarely, when an individual or location was important to sample but no buds or open flowers were present. Herbarium specimens (when flowers were mounted with reproductive parts facing up) were an extremely valuable source for pollen analysis. Floral remnants in packets were preferentially sampled. Otherwise anthers were removed with forceps from mounted flowers. The standard sample size was four anthers from one flower. Rarely, when direct access with forceps was not possible, pollen was instead tapped out of partially closed, mounted buds or inconveniently-oriented mounted flowers. Pollen grains were stained and macerated in cotton blue in lactophenol following Powell et al. (1991) and left at least overnight before observation. Pollen stainability percents were based on a count of ca. 200 grains or, in cases of low pollen productivity, the total amount of pollen grains contained in the four-anther sample. As pollen grains sampled were derived from macerated anthers, the incidence of mixed pollen from other plants was considered to be insignificant for purposes of this study; non-Opuntiae pollen grains were noted in a handful of samples, identified easily by different size, shape, and surface projections. Low-staining pollen samples were those with a lower than 50% stainability result. High-staining samples were those with above 70% stainability.

Field observations, voucher specimens. Voucher specimens were open-air dried without the use of ETOH. Tepal samples from various populations across the species' ranges were collected and placed in plastic vials with silica gel, enabling future genetic study by interested researchers. All specimens and tepal samples, unless otherwise noted, are housed at SRSC. All five of the CSC taxa were observed in the field across their known ranges in the USA (excluding *Corynopuntia emoryi* populations outside of Texas). All key morphological characteristics (often not apparent once pressed and dried as a specimen) were recorded as label data including joint shape, ease of joint disarticulation, root morphology, joint growth origin, and filament color. Herbarium specimens of CSC taxa, in addition to some associated species in the southwestern USA and Mexico, were examined via loans from the following herbaria: ASC, NMSU, MICH, TEX-LL, UNM. Digital images of specimens were also utilized (SEINET 2014; JSTOR Plant Science 2014). Primary collector names are used to cite specimens; use of 'et al.' indicates that secondary collectors are listed in label data.

Collector abbreviations and names used frequently in this paper, including the appendices, are as follows: ADZ = Alan D. Zimmerman; AK = Ad Konings; AMP = A. Michael Powell; AS = Anna Strong; BER = Barbara E. Ralston; BGH = Barry G. Hughes; BHW = Barton H. Warnock; CJ = Chris Jackson; DB = Daniel Brailovsky; DJP = Donald J. Pinkava; DOK = Don O. Kolle; DW = Del Weniger; EUC = Elzada U. Clover; GCR = Gerald C. Raun; GW = Gil Wiens; JEH = Jean E. Hardy; JF = Joselyn Fenstermacher; JFS = James F. Scudday; JFW = James F. Weedin; JL = Janice Lewis; KHS = Karl H. Schwerin; LCH = Leon C. Hinckley; MAB = Marc A. Baker; ME = Michael Eason; MSA = Margery S. Anthony; PRM = Patricia R. Manning; RDW = Richard D. Worthington; RM = Roy Morey; SL = Shane Lee; TG = Tony Gallucci; TP = Tom Patterson; WW = Wendy Weckesser.

RESULTS

A total of 272 new collections were made and utilized as vouchers for cytologic studies as well as to provide populational and morphologic documentation. More than 75 potted specimens were used for cytologic and morphologic study as part of a living collection maintained at a Sul Ross State University greenhouse. Several individuals remain in cultivation at the Chino Valley, Arizona, garden of Marc Baker. Tepals from over 100 individuals are available for genetic study. Cursory measurements of stomata, pollen grain size, and average stomata density revealed no correlation with ploidy level.

Chromosome counts. New chromosome data are reported for 81 individuals representing four of the five CSC species and three putative hybrids (Appendix A); *Corynopuntia emoryi* was not counted. The results of the present study support the previously reported chromosome numbers for CSC species (Appendix B). Though *C. schottii* has been widely believed to be a tetraploid, the new hexaploid counts ($2n$ = 33 II) reported here support one previously published hexaploid count reported for the species (Yuasa et al. 1973) though the data are unverifiable as no voucher exists (Govorounova, pers. com. 2015). Meiosis was observed to be consistently regular in *C. aggeria* whereas irregular meiosis, including univalents and multivalents, was observed in *C. densispina*, *C. grahamii*, and *C. schottii*. No collections of *C. aggeria* were meiotically sterile, i.e., having irregular and/or absent microsporocytes, whereas the remaining species demonstrated varying degrees of sterility (Table 1). The first pentaploid and triploid counts known for the genus were made from individuals identified as *C. grahamii*. Triploid counts were also made for putative hybrids of *C. aggeria* × *C. densispina* and *C. aggeria* × *C. grahamii*. Tetraploidy, as well as meiotic sterility, were observed in multiple putative *C. aggeria* × *C. grahamii* individuals. An additional putative hybrid, *C. grahamii* × *C. schottii*, proved to be meiotically sterile, i.e., microsporocytes were entirely absent in the sample.

Table 1. Incidence of absent or irregular microsporocytes in flower bud samples used for chromosomal analysis in the *Corynopuntia schottii* complex species. *C. emoryi* was not sampled for chromosomal analysis.

	C. aggeria	*C.densispina*	*C. emoryi*	*C. grahamii*	*C. schottii*
Proportion sterile samples: total samples	0:34	2:26	n/a	4:10	3:6
% sterile samples	0	8	n/a	40	50

Pollen stainability. Pollen stainability was measured from 185 individual flowers representing at least 147 individuals (Appendix C, D). For several voucher specimens, a populational sample of flowers was made additional to harvesting flowers directly from the vouchered individual. Average percent stainability differed somewhat between species (Fig. 2 A), but *Corynopuntia aggeria* and *C. densispina* had the greatest proportion of higher staining grains (Fig. 2 B) and the least proportion of pollen sterility (i.e., anthers lacked pollen entirely) compared to the other taxa (Fig. 2 A). Pollen sterility was observed in all taxa, most commonly in *C. grahamii* (Fig. 2 A). All species showed a range in fertility both within populations (Fig. 2) and across the geographic ranges (Appendix C). At least one sample from each of the CSC species contained two or more sizes of pollen grains, which were variously stained and unstained (Appendix C).

Some *Corynopuntia schottii* flowers observed in populations had few functional anthers with little pollen, yet stained at high percentage (*JF 2404, 2434*). Another individual sampled had flowers with smaller filaments/anthers and few, low-staining grains, as well as flowers with longer/larger anthers containing abundant pollen staining around 50% (*JF 2430*). Other *C. schottii* collections were found to lack pollen entirely (*BER 103*), or were noted as having abnormal meiocytes via chromosome sampling (*AMP 6248*); both vouchers also contain flowers with abundant and high-staining pollen (Appx. D).

Geographic/morphologic data. The known ranges of CSC species across Texas as well as southeastern New Mexico and northern Mexico are now better understood by plotting new collections and verified herbarium records (Fig. 3 A-B). Field observations and examination of herbarium specimens, bolstered by cytologic work, uncovered multiple characteristics that reliably distinguish the CSC species (Appendix E), summarized in the treatments below. Despite the wide variability in *C. aggeria* spination, the characters recognized as taxonomically reliable for the Big Bend Opuntiae (Anthony 1956), i.e., habit of stem and root growth, joint shape, and form and color of spines as opposed to the size of joints and the length and number of spines, do appear to consistently distinguish Big Bend club chollas. Several collections, detailed below, are putatively identified as hybrids based on mixed morphologic characters relating clearly to sympatric taxa. Additional collections from three geographic areas, the O2 flats in mid-Brewster County, Texas (*MSA 1174, 1304* MICH; *CJ 364, 310, 265* SRSC), south of Sierra Blanca in Hudspeth County, Texas (*KHS 4123/UNM 52089, 52508* UNM), and southwestern Otero County, New Mexico (*GW 3809-A, 3809B, 3811, 3843, s.n./UNM 67866, s.n./UNM 86355* UNM), have not been confidently identified because their characters represent non-sympatric taxa; details are given under the respective treatments below.

Notes on terminology used in species treatments below (important terms are in **bold**):
Orientation. Many terms can be employed in reference to a location above or below an imaginary horizontal line bisecting an areole or other cactus structure (e.g., chain of cladodes/joints, single joints, spines) in half (Fig. 4). For example, when facing an areole straight on, adaxial refers to the upper half of the areole; synonyms for adaxial include apical, distal, upper, and above. The term abaxial refers to the lower half of the horizontally bisected areole; synonyms for abaxial include

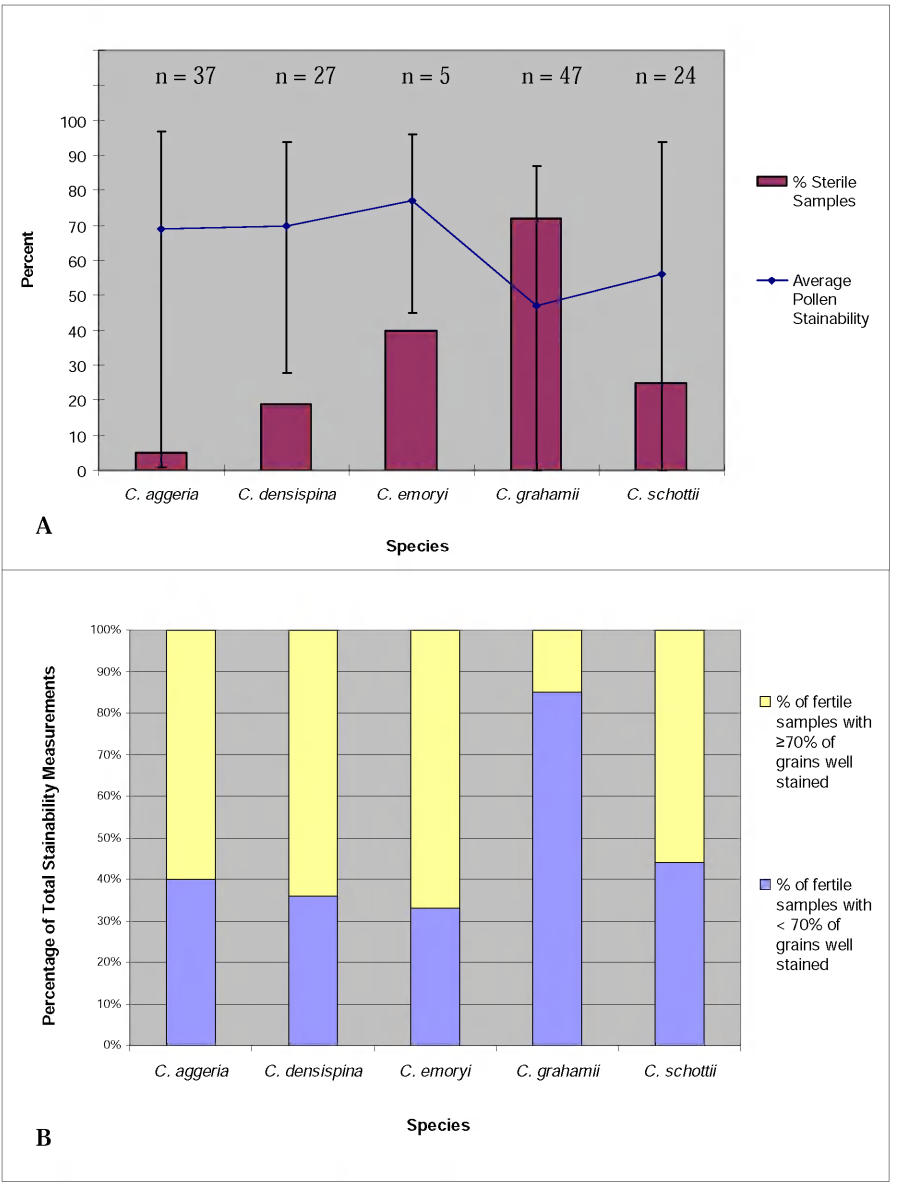

Figure 2. Pollen stainability in the *Corynopuntia schottii* complex. A. Average stainability relative to pollen sterility (lacking pollen entirely); error bars show range of stainability measured in each species; n is the total number of samples measured. B. Percent of fertile samples that were "well stained" (>70%) and "low staining" (<70%).

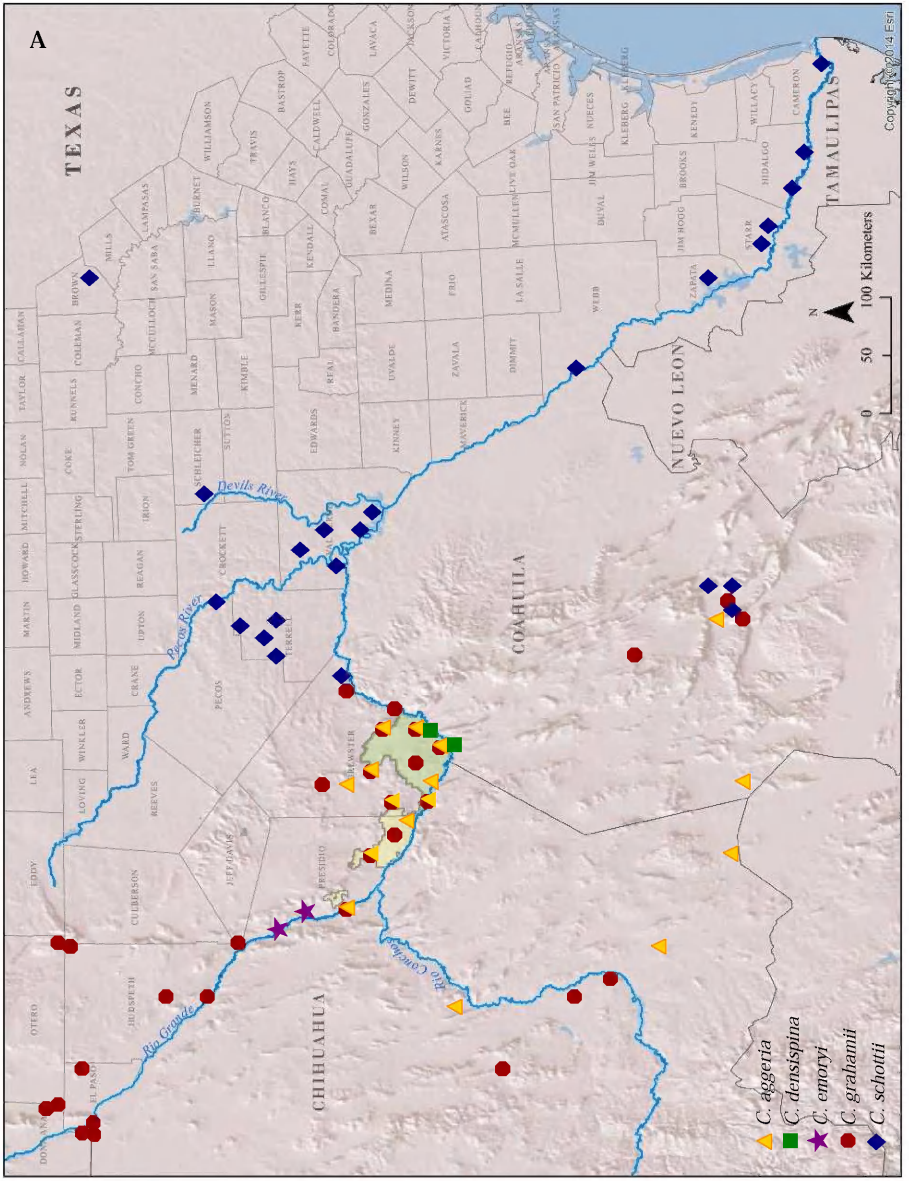

Figure 3. Representative voucher collection locations for the five *Corynopuntia schottii* complex species. A. Texas and adjacent Mexico.

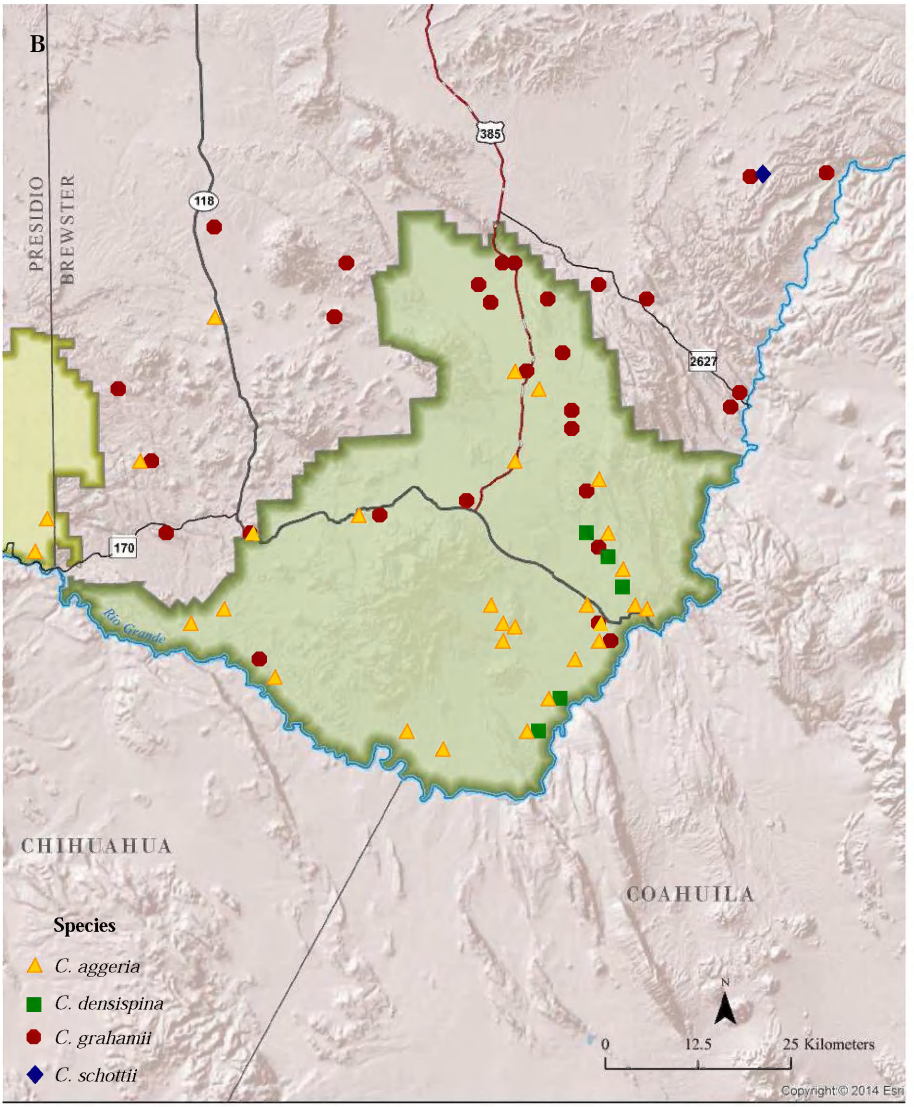

Figure 3. Representative voucher collection locations for the five *Corynopuntia schottii* complex species. B. Big Bend National Park, Texas, and environs.

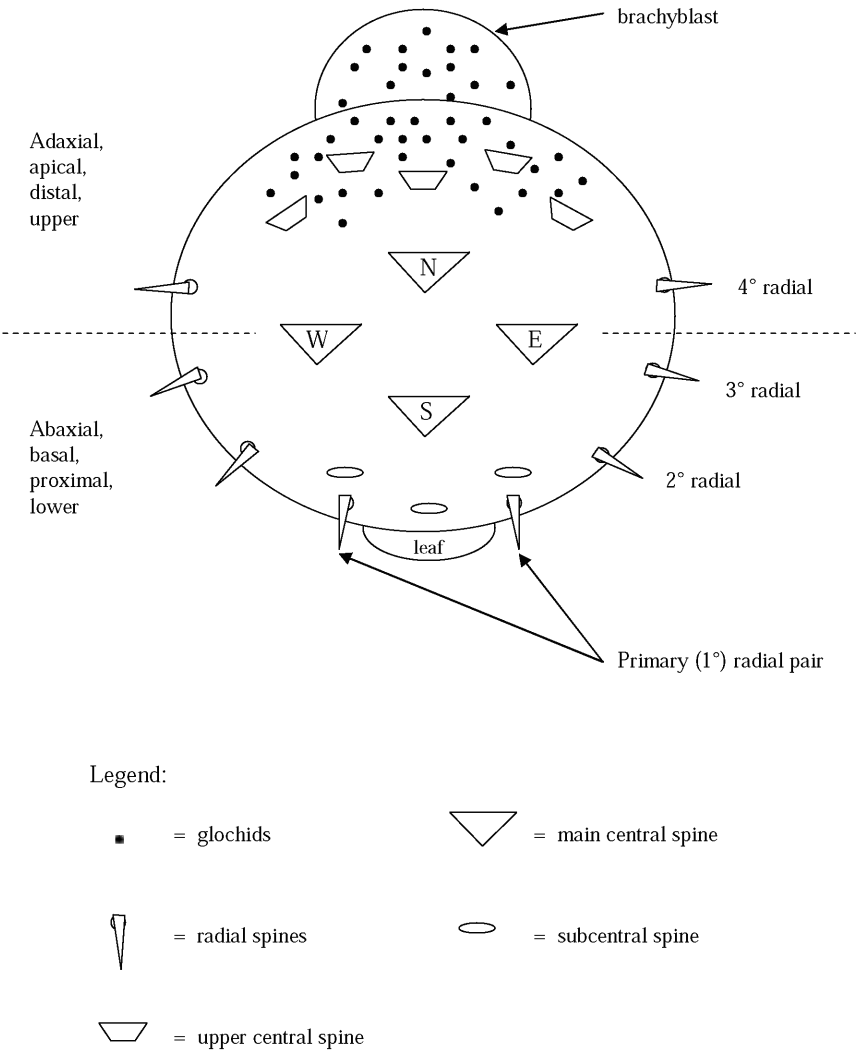

Figure 4. An idealized, representative areole of *Corynopuntia schottii* complex species showing all relevant structures, spine architecture, and orientation vocabulary. The four 'core' central spines are labeled N, S, E, W representing points of the compass for ease of individual identification.

basal, proximal, lower, and below. In structures larger than an areole, for example, apical would refer to the furthest-from-the-root portions of the plant, where basal refers to the closest-to-the-root but above-ground portions of a plant. Apical also refers to the tips of plant components such as spines or joints, and basal—as its opposite—refers to where those structures are attached.

Roots. Cacti are often described as having either "tuberous" or "fibrous" roots but more subtle designations are needed to accurately describe the variation in Big Bend club chollas. For the current study, **tuberous roots** are considered conic-fusiform shaped: those that are enlarged 2-3 cm broad or even wider, elongated (not round or turnip-shaped), and frequently constricted at the root origin but always constricted towards the distal end of the tuber. The creamy-white, fibrous interior of a tuberous root is covered with a papery, shedding, protective epidermal layer. Plants with tuberous roots may also grow relatively more diffuse roots, which can emanate from the tuber or adventitiously from stems at edges of mounds. These may or may not have thin, fusiform-shaped swellings, but in species described as having tuberous roots there will always be a central core of one or more thick, fusiform tubers as the main underground structure.

Diffuse roots do not contain any swellings, lumps, or bumps within or along the root tissue. Diffuse roots are always fibrous in nature and include both thickened and filiform roots. A **thickened root** refers to the existence of one central taproot which is clearly the widest and longest of the underground structures, and is either the same width along its length or tapers evenly towards the tip. Along with a thickened tap root, many other diffuse roots (2-4 mm wide) are usually present and are covered by a papery, shedding, epidermal layer, as are the thickened and tuberous roots. **Filiform roots,** are fine and hair-like in nature (<2 mm wide) and generally lack the papery epidermal layer, instead having a fuzzy covering of very fine root hairs to which fine particles of substrate often remain attached, regularly persisting and notable in prepared herbarium specimens.

Plant structures. Following Bárcenas (2004) the following structures are here defined: areoles on the green photosynthetic stems are called **axial areoles**; modified stem tissue surrounding the flower is the **pericarpel**; and areoles on the pericarpel are **pericarpelar areoles**. Newly termed here is the **pericarpel rim**: the junction of the pericarpel and the base of the tepals, best seen at the bud stage of flower growth (Fig. 5). **Inflated tubercles** are those with a rounded or humped abaxial profile and that, when dry as in an herbarium specimen, maintain a rounded and mammillate appearance (Fig. 6 A). Such tubercles are always clearly laterally compressed, and are raised in obvious relief from the central stem surface. **Deflated tubercles** have a relatively flattened abaxial profile, do not appear linear in shape nor laterally compressed when turgid, and when pressed and dried they appear flattened, as if lacking internal structure, and do not retain a rounded or mammillate appearance (Fig. 6 B).

Spination. Newly detailed here are two distinguishing characters for mature areoles of Big Bend area club cholla species: 1) the presence or absence of **subcentral spines** (Powell & Weedin 2004) — shorter and thinner, lower central spines (Fig. 4); and 2) the relative length of the **primary radial spine pair**, i.e., the two radial spines most abaxial in the areole. Spination has the potential to be very confusing in the CSC species, but there is an abiding core structure in the spine habit for all five species: central spines are oriented around a core group of usually four spines in a "crucifix" pattern, easily represented by the cardinal directions (N, S, E, W); radials occur along the areole periphery; and newer 'upper' central spines emerge at the apex of the areole intermixed with glochids (Fig. 4). When subcentrals are present, there are three of them and they are located below the main four central spines (Figs. 4, 7). A **diminutive subcentral** is a medial subcentral that is noticeably shorter, thinner, and lighter in color than the lateral subcentrals and markedly so in comparison to the central spine directly adaxial to it (Fig. 7 C-D).

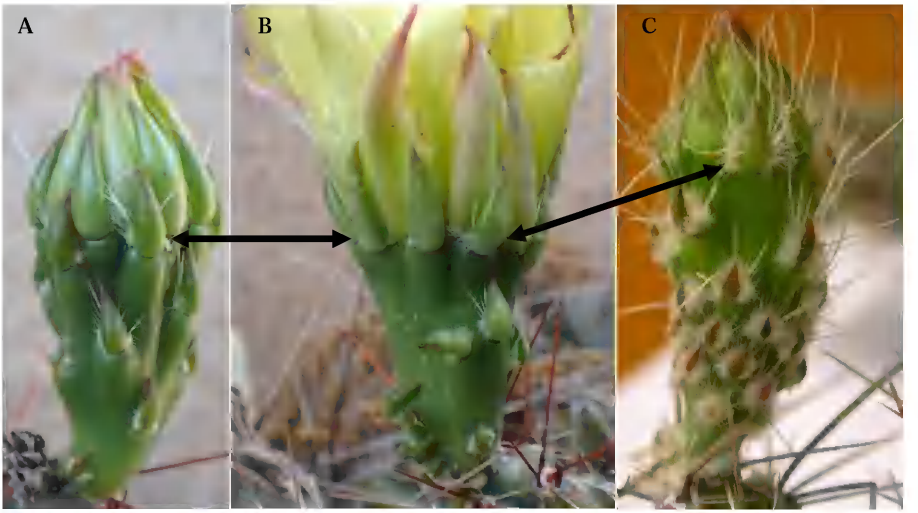

Figure 5. Pericarpel rim location, indicated by black arrows. A-B. *Corynopuntia aggeria*. C. *C. grahamii*. Note the difference between species regarding number of bristle spines at the pericarpel rim as well as the amount of wool in, and density of, pericarpelar areoles.

Figure 6. Examples of tubercle morphology types. A. Inflated, *Corynopuntia grahamii*. B. Deflated, *C. schottii*.

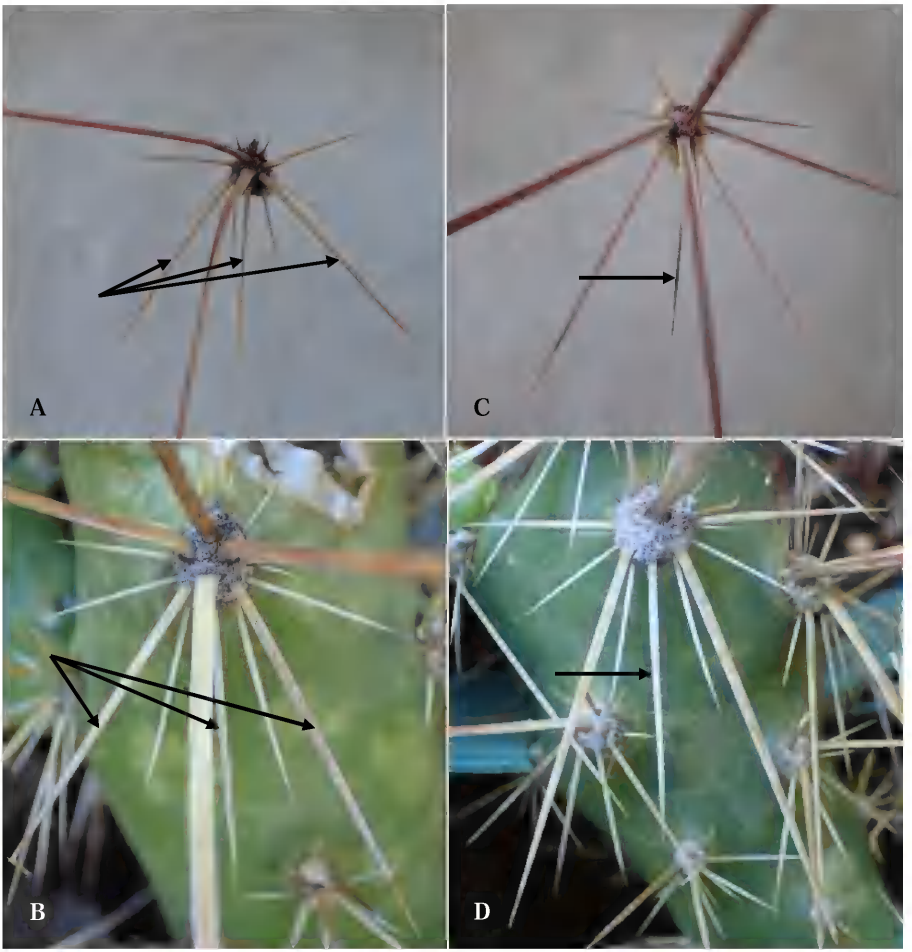

Figure 7. Subcentral spines in Big Bend *Corynopuntia*. A-B. Spine clusters of *C. emoryi* with arrows showing the three equal subcentrals. C-D. Spine clusters of *C. schottii* with arrows indicating the one diminutive subcentral spine.

Despite being slighter in size, the subcentrals are actually the oldest spines in the areole, apart from the primary pair of radials. Following the "mixed" sequence of spine maturation (Gibson and Nobel 1986), after the subcentrals emerge at the adaxial meristem of the areole, they are subsequently pushed downwards abaxially in the areole as they are eclipsed both in location and in robustness by the successively generated central spines (Fig. 8). Subcentrals, having been the first to develop, are thus situated below the main centrals, and the most recently emerged central spines—or "upper" centrals, are situated above the main centrals in mature spine clusters.

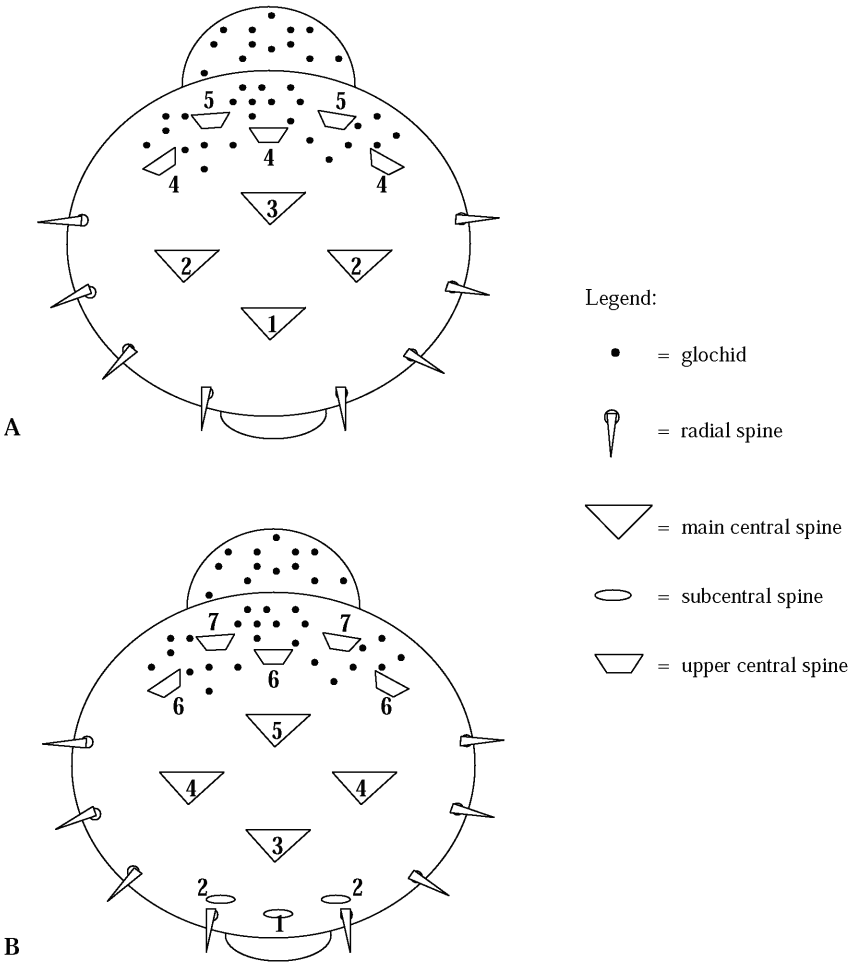

Figure 8. Central spine genesis order in *Corynopuntia schottii* complex species, with 1 being first i.e., oldest. A) Order when subcentral spines are not present. B) Order when subcentrals are present. After Gibson & Nobel (1986).

Generally, radial spines occur at the periphery of stem areoles, usually in the abaxial half of the areole. In the Big Bend club chollas radial spines are borne in a more descending or appressed orientation than the more globally-radiating central spines. Consistently across CSC taxa, radial spines occur in radially-symmetric "pairs." The first, primary, or 1° pair — the one that emerges earliest — is the longest and most basal in the areole, with successive pairs (i.e., 2°, 3°) ascending the periphery of areole to about the 3 o'clock/9 o'clock position, even as high as 1-2 o'clock/10-11 o'clock in *C. grahamii* (Figs. 4, 9). As the radials ascend the areole periphery they decrease in length with each pair.

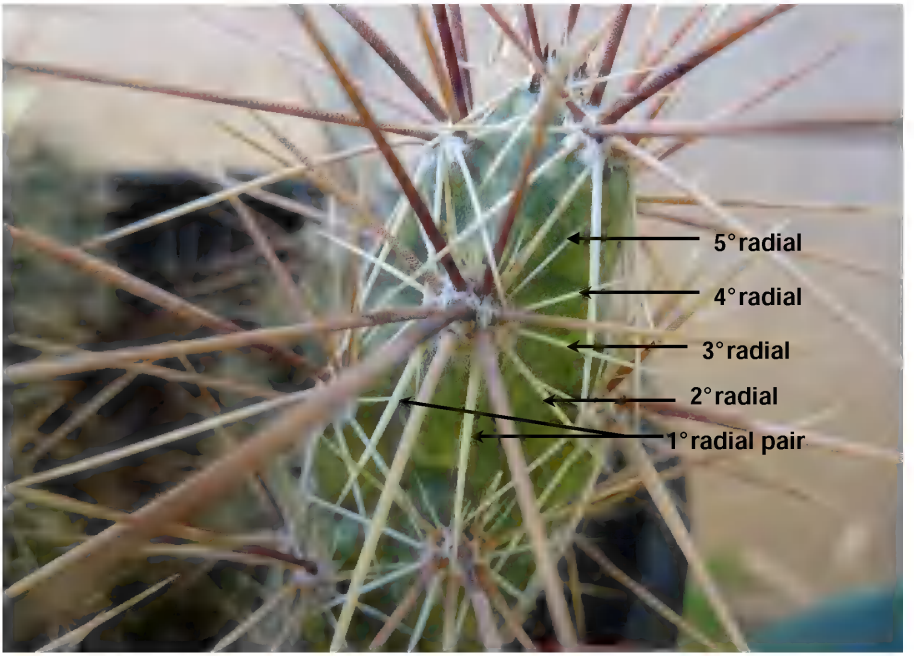

Figure 9. Example of radial spine aspect in Big Bend *Corynopuntia*. All species will have at least the primary (1°) pair of radials most abaxially in the areole whereas *C. grahamii*, especially those with 'classic' morphology as shown above, will often have three or more radial pairs.

Glochids in distal joints are borne in the upper third of mature axial areoles, sometimes mixing with incipient centrals. As described in Bárcenas (2004), stem and pericarpelar areoles of *Corynopuntia* [*Grusonia*] can have different shapes and spine arrangements. In the CSC species this includes occasional production of small apical **brachyblasts** (Fig. 4): raised, wooly structures in the most extreme adaxial areolar position that contain only glochids (Fig. 10). Several CSC species commonly also have **protruding basal areoles:** stem-tissue areoles in the lower-most parts of the plant just above the ground, which are raised significantly from the stem surface in part due to their abundant villous wool. Though these protruding basal areoles lack central spines they do contain abundant, usually radially-symmetric glochids (Fig. 11). In areoles of the pericarpel rim, of all CSC taxa, instead of glochids there are **bristle spines** occurring with conic leaves. Bristle spines are longer than glochids, more flexible and slender than central spines, have retrorsely-barbed tips, and are easily detached (e.g., Fig. 5 C).

Figure 10. Brachyblasts in areoles of Big Bend *Corynopuntia*. A) *C. aggeria*. B-C) *C. grahamii*.

Figure 11. Protruding basal areoles in *Corynopuntia aggeria*. Note radially-symmetric aspect of glochids and abundant wool.

Spine color and form. Coloration and form of spines have been suggested to be good taxonomic characters in opuntiads (s.l.), though both characters may exhibit some variability in different environmental settings (Anthony 1956). In CSC taxa, the color of central spines can be longitudinally **streaked** with white, usually with the amount of white increasing distally (Fig. 12 A). Alternatively, central spines can be **saturated** with color (i.e., no white streaking, Fig. 12 B). If saturated, the tone of color is often blotchy, i.e., having 3-5 subtly lighter and/or darker transverse bands along the lengthof the spine. The thickness of the spine epidermal layer influences spine color. Indicative of

Figure 12. Spine color characteristics in Big Bend *Corynopuntia*. A) Streaky central spines of *C. aggeria*. B) Saturated central spines of *C. grahamii*. C) Iridescent bulbous central spine bases of *C. grahamii*.

Corynopuntia, the layer of sclerified epidermal cells appears as a 'skin' or a 'sheath' covering the spine's fibrous core (Mauseth 2006), and is shed only at the tips of spines as they mature. The remaining indehiscent, tightly-attached epidermal cells affect the way spine color appears to the naked eye, especially in that they create differing surface topography and cell patterns. Thicker layers

of epidermal cells make the spine appear whiter as the cells increasingly obscure the underlying color, observable in radial spines of most species. Thinner, or even absent, cell layers allow more of the underlying color of the spine to appear; this is especially apparent in the iridescent and comparatively boldly-colored spine bases of *C. grahamii* (Fig. 12 C).

Differences in spine epidermal cells, epidermal cell patterns, and spine surface topography for club chollas were also noted by Bárcenas (2004); selected terms modified for use here include: **ridged** – irregular projections of the spine surface resembling appressed, sclerified trichomes which occur either singly, in pairs, or as several in a series which coalesce into rough slanted ridges, the "ridges and valleys" making the spine surface appear papillate to the naked eye (Fig. 13 A-C); **farinose** – thick, whitish or light-gray epidermal cells, often with microscopic black globular markings, the cells particularly thick at spine edges (Fig. 13 D); **longitudinally striate** – longitudinal grooves and microscopic black streaks not globules (Fig. 13 E).

FIELD KEY TO BIG BEND *CORYNOPUNTIA*

1. Joints (especially distal ones) weakly attached, readily disarticulating.

    2. Distal joints ovoid-obovate; new joints originating from apical areoles; central spines terete, pink to red-brown (no white); roots of one to several conic-fusiform tubers; central spines of mature areoles all of similar length; flowers yellow, occasionally dusky pink ..... **Corynopuntia grahamii**
    2. Distal joints clavate, J-shaped; new joints originating from lateral areoles; central spines flattened, tan to red-brown, often with white margins; roots diffuse, the majority filiform (well-established plants may also have a slightly-thicker main taproot, possibly several times longer than the height of the plant); central spines of mature areoles include three subcentrals with the medial spine being shorter than the two lateral subcentrals and < 1/2 the length of the main central spine; flowers yellow ..... **Corynopuntia schottii**

1. Joints firmly attached.

    3. Joint length usually exceeding 9 cm; central spines (medial and abaxial) flat, uppers often terete, with all spines tan-brown (no white) and evenly colored along the entire length of the spine; spine bases (centrals only) not bulbous nor differently colored than the rest of the spine; one main central spine (longest, broadest); subcentrals present, three, of generally equal length; near Candelaria or Porvenir in extreme southwestern Presidio County, Texas ..... **Corynopuntia emoryi**
    3. Joint length usually less than 9 cm; central spines flattened and variously colored (including white, especially distally); spine bases (all) bulbous and differently colored than the rest of the spine; no clear dominant central spine; subcentrals absent; in southern Brewster and Presidio counties.

        4. Habit a well-defined, contiguous to patchy mound of tightly-associated stems; joints clavate and erect-oriented, growing from mostly lateral areoles; central spines 1-4(-7); primary radial spine pair (the most abaxial) less than half the length of central spines; roots conic-fusiform tuber(s) ..... **Corynopuntia aggeria**
        4. Habit an open, sprawling mound of loosely-aggregated stems; joints clavate (often slightly J-shaped) and erect-oriented to sprawling in chains, growing from lateral areoles; central spines 7-11+; primary radial spine pair (the most abaxial) greater than half the length of the central spines; roots diffuse/adventitious, usually with a long, thickened, distally tapering tap root ..... **Corynopuntia densispina**

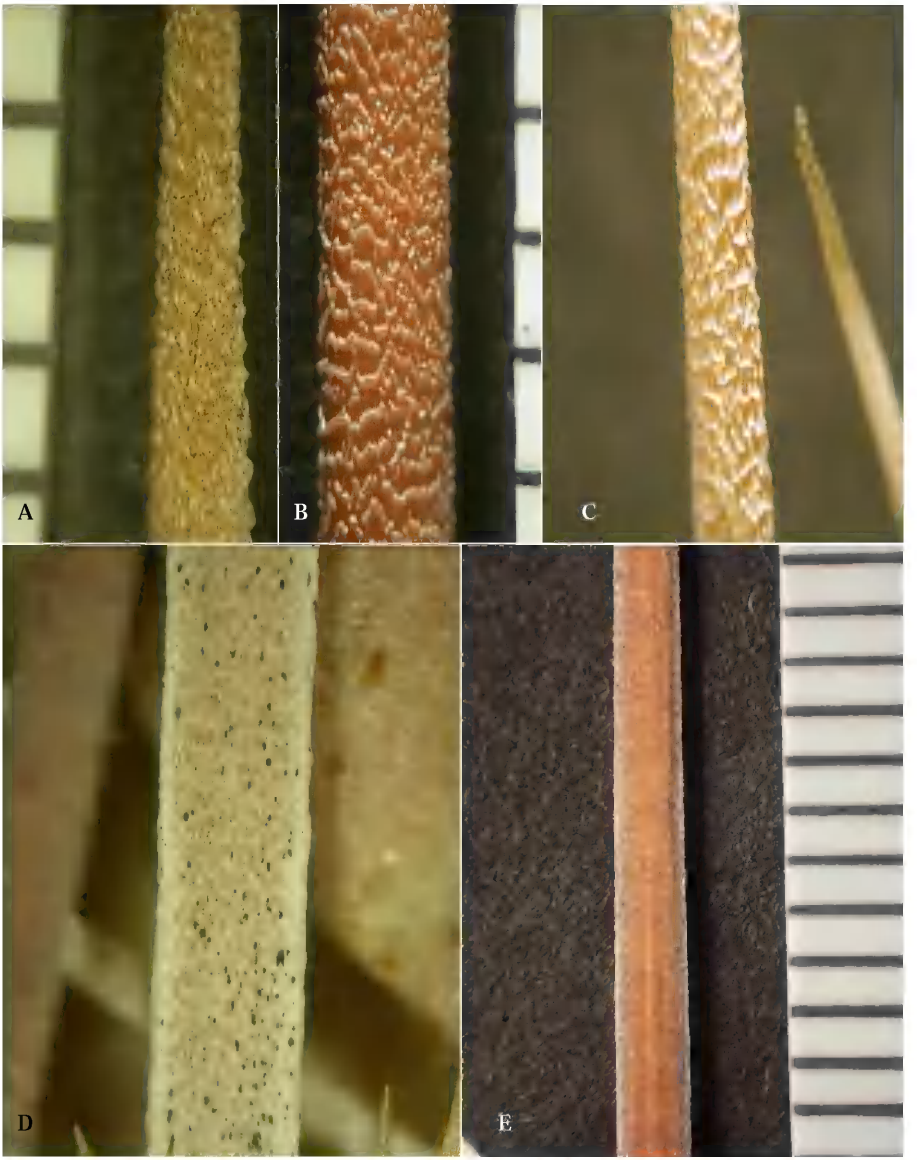

Figure 13. Central spine epidermal characters of Big Bend *Corynopuntia*. A-B) Ridged surfaces of *C. emoryi*. C) Ridged surface of *C. grahamii*. D) Farinose surface of *C. aggeria*. E) Smooth, longitudinally striate surface of *C. schottii*.

HERBARIUM KEY TO BIG BEND *CORYNOPUNTIA*

1. Joints ovate; central spines terete, less than 1 mm wide, numbering no less than 4, colored mauve, peach, or darker red, with saturated tone (no white) and with bulbous, iridescent bases; radial spines (4–)6 or more, terete, white, bulbous iridescent bases ..... **Corynopuntia grahamii**
1. Joints clavate; central spines flattened, greater than or equal to 1 mm wide, of various numbers and colors; radial spines generally 2–4, flattened, white to tan, bases bulbous/iridescent or not.

    2. Central and radial spines the same color (tan-brown) and saturated, containing no white (rarely with lighter-colored margins in largest central spines) ..... **Corynopuntia emoryi**
    2. Central spines variously colored but all with at least some white/gray in the most mature clusters; radial spines white or significantly lighter in color than central spines.

        3. Central spines tan, copper, or dark red-brown, and saturated, the only white being at the extreme margins of most mature central spines; diminutive lower central spine present; radial spines lighter in color than central spines ..... **Corynopuntia schottii**
        3. Central spines colored variously but containing some white in addition to or other than along spine margins; diminutive lower central spine absent; radial spines white.

            4. First radial pair greater than or equal to half the length of lower central spines; central spines 7–11+; roots diffuse perhaps with one thickened, distally-tapering taproot ..... **Corynopuntia densispina**
            4. First radial pair less than half the length of the central spines; central spines 1–4(-6–7); roots conic-fusiform tuber(s) ..... **Corynopuntia aggeria**

TAXONOMIC TREATMENTS

CORYNOPUNTIA AGGERIA (Ralston and Hilsenb.) M.P. Griff., Haseltonia 9: 91. 2002. *Opuntia aggeria* Ralston & Hilsenb., Madroño 36: 226. 1989. *Grusonia aggeria* (Ralston & Hilsenb.) E.F. Anderson, Cact. Succ. J. (Los Angeles) 71: 324. 1999. **TYPE: USA. Texas**. Brewster Co.: Big Bend National Park, Tornillo Flats, 2800 ft., Jul 1948, *M.S. Anthony 856* (holotype: MICH!). AGGLOMERATED CLUB CHOLLA. Figs. 14-15.

Plants of *Corynopuntia aggeria* are most abundantly found in upper Cretaceous, gypsiferous and/or clay-containing limestone soils on gravelly alluvial slopes and hummocks. *Corynopuntia aggeria* is commonly found in mixed or closely associated populations of *C. grahamii* as well as sympatrically with *C. densispina* (Fig. 3; B), although *C. aggeria* appears to occur in slightly more elevated locations than *C. densispina*. *Corynopuntia aggeria* is consistently diploid despite wide morphologic variation, especially in spine color, abundance, and form, within and between populations.

In addition to chromosome number, *Corynopuntia aggeria* is distinguished from other species by the following: (1) habit of discrete, cushion-like mounds, (2) taproots conic-fusiform-tuberous, from which may emerge a few fibrous-tuberous roots, all with a shedding papery-cork epidermal layer, (3) stems ascending, without clear above-ground central point of growth, (4) joints clavate, laterally-growing, firmly-attached, tightly-associated, (5) central spines flat adaxially and angled abaxially, containing white coloration especially distally, (6) radial spines four or less and relatively short, and (7) filaments red/pink (recorded as green in Ralston & Hilsenbeck 1989, though original type description stated red, Anthony 1956). The pericarpelar areoles *C. aggeria* are less dense, have fewer glochids, and have fewer bristle spines on the pericarpel rim than the often co-occurring *C. grahamii*. Also, *C. aggeria* is earlier to bud and flower than *C. grahamii* and *C. densispina*, although their flowering seasons do overlap.

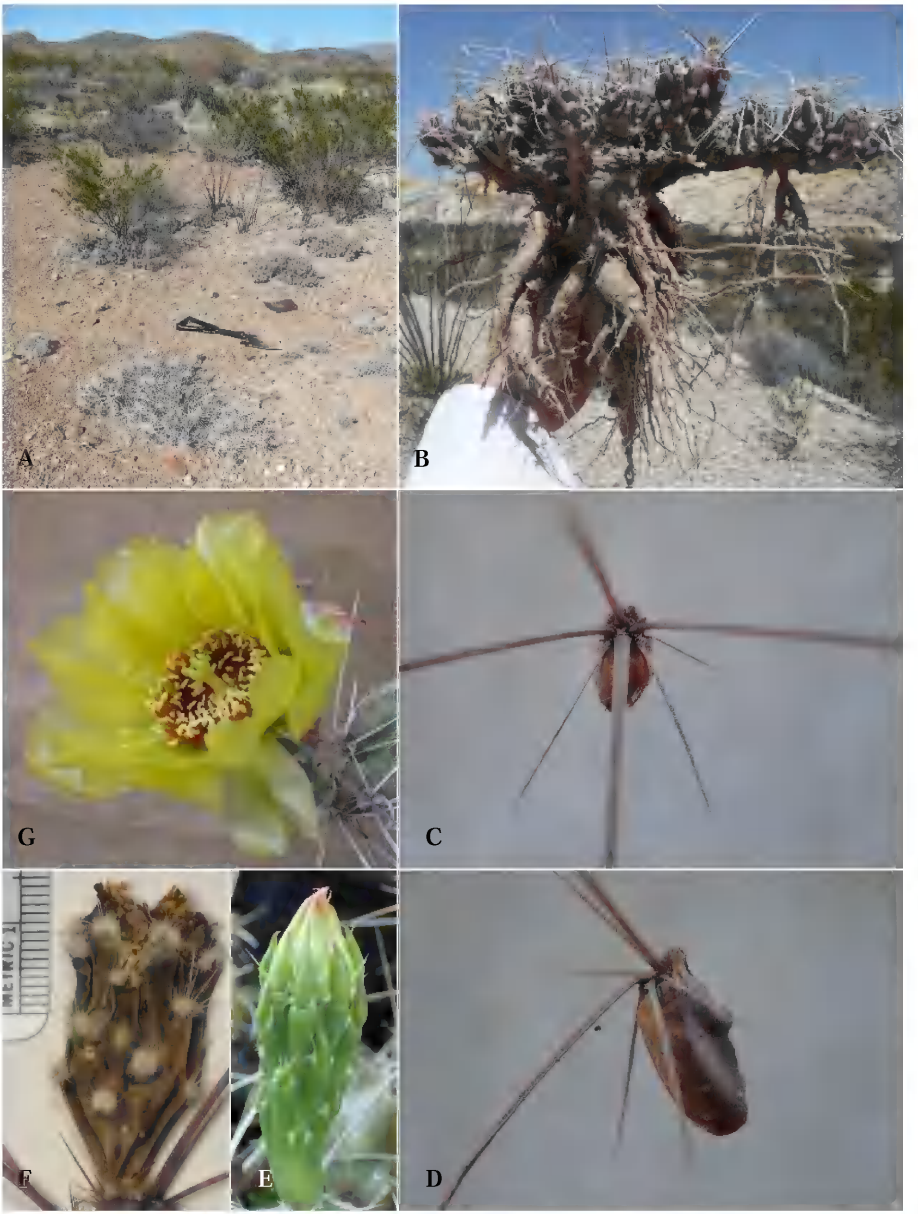

Figure 14. *Corynopuntia aggeria.* Clockwise from top left. A. Habitat. B. Root and joint habit. C. Spine cluster, front view. D. Spine cluster, profile view. E. Bud. F. Fruit. G. Flower.

Figure 15. *Corynopuntia aggeria* morphotypes. A. Dense. B. Decurved. C. Boquillas. D. Gochidiate. E-F. Sparse.

Several basic morphotypes of *Corynopuntia aggeria* are common in its populations (Fig. 15), generally graded by robustness of joints and central spine number/character. One population along the Boquillas Canyon road in Big Bend National Park, in addition to including basic morphotypes, also contained diploid individuals with elongated clavate-cylindric joints, long thin spines, and roots apparently all thickened-fibrous, i.e., no clearly tuberous taproot (e.g., *JF 1563, 2344, 2345*). One herbarium specimen matching many characteristics of *C. aggeria* (clavate joints, few spines, red filaments) has been collected approximately 161 kilometers east of El Paso, which appears to be just west of Van Horn (*Neuman s.n.* DES); attempts to relocate this population have been unsuccessful and because the locality is significantly outside the known range for the species, a confident identification is difficult without root or joint attachment information.

CORYNOPUNTIA DENSISPINA (Ralston & Hilsenb.) J. Fenstermacher, **comb. nov.** *Opuntia densispina* Ralston & Hilsenb., Madroño 39: 281, fig.1. 1992. *Grusonia densispina* (Ralston & Hilsenb.) Pinkava, J. Arizona-Nevada Acad. Sci. 34: 45. 2002. **TYPE: USA. Texas.** Brewster Co.: Big Bend National Park, on River Road ca. 5.3 mi E of Mariscal Mine [erroneously recorded as Solis Ranch in the original description] near Solis junction, May 1989, *B.E. Ralston 200* (holotype: SRSC!; isotype: SRSC!, TEX). DENSELY-SPINED CLUB CHOLLA. Fig. 16.

Previously known only from the isolated type locality with its low-lying, extremely clay-rich soils, new populations were found during this study that expand the known range by ca. 26 kilometers and the habitat to include low-lying, gravelly, fine-sandy loam as well as higher, tighter, rockier limestone. *Corynopuntia densispina*, in all known populations, occurs sympatrically with *C. aggeria* (Fig. 3; B) but *C. densispina* is more abundant in lower-lying areas with high clay content.

Corynopuntia densispina is consistently tetraploid across its range, and is additionally distinguished from other species by 1) habit of loosely-aggregated, sprawling mounds, 2) roots consisting of one long, slender, tapering taproot with many straggly, diffuse roots adventitiously growing from lateral stems, all roots with a shedding papery-cork epidermal layer, 3) stems ascending-to-prostrate without a clear above-ground central point of origin, 4) joints clavate, laterally-growing, firmly attached, robust, 5) central spines $\geq$7, flat adaxially, angled abaxially, 6) primary radial spines relatively long, and 7) filaments red, pink, or green. At a distance, sunlight reflection from some mounds of *C. densispina* appears as a silvery sheen due to the higher number of relatively thin and long, grey- to straw-colored central spines. This can help distinguish *C. densispina* from mounds of nearby *C. aggeria* in some locations. The morphologic similarity of the tetraploid *C. densispina* to the denser-spined, more robust morphotype of the diploid *C. aggeria*, along with their contiguous distributions (and often ecologic segregation) across several populations, suggest that *C. densispina* is an autopolyploid derived from *C. aggeria*.

CORYNOPUNTIA EMORYI (Engelm.) M.P. Griff., Haseltonia 9: 91. 2002. *Opuntia emoryi* Engelm., Proc. Amer. Acad. Arts 3: 303. 1857. *Grusonia emoryi* (Engelm.) Pinkava, J. Arizona-Nevada Acad. Sci. 32: 50. 1999. *Opuntia stanlyi* Engelm. ex B.G. Jacks., Notes of a Military Reconnaissance, 7. 1848. *Grusonia stanlyi* (Engelm. ex B.D. Jacks.) H. Rob., Phytologia 26: 176. 1973. *Corynopuntia stanlyi* (Engelm. ex B.D. Jacks.) F.M. Knuth, Kaktus ABC, 114. 1936. **LECTOTYPE** (Bárcenas et al. 2012): **MEXICO. Chihuahua**. Arid soil south and west of El Paso, especially between the Sand hills and Lake Santa Maria, *J.M. Bigelow s.n.* (MO! sheet 178185; isolectotype: NY). Other original materials: *Engelmann s.n.*, MO; *Parry+ s.n.*, NY!; *Wright s.n.*, MO). DEVIL CLUB CHOLLA. Fig. 17.

Corynopuntia emoryi has a limited range in the western Big Bend, occurring in rocky, silty-sandy soils near the Rio Grande communities of Porvenir and Candelaria in Presidio County. It is highly likely that *C. grahamii* occurs sympatrically with *C. emoryi*, based on distribution both

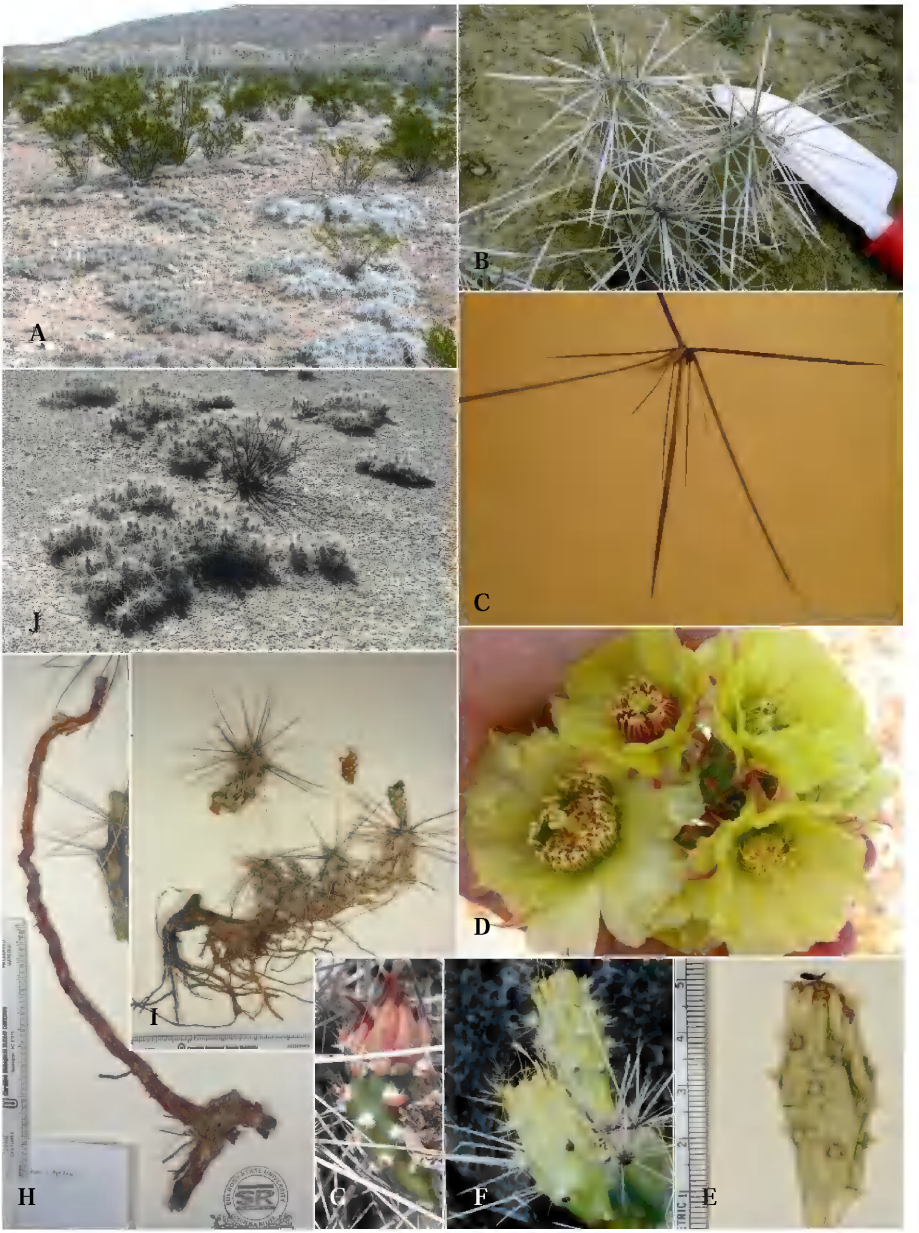

Figure 16. *Corynopuntia densispina*. Clockwise from top left. A. Mound habit. B. Joints. C. Spine cluster. D. Flowers. E-F. Fruit. G. Bud. H-I. Roots. J. Mound habit.

Figure 17. *Corynopuntia emoryi* from Candelaria, Texas, population. Clockwise from top left. A. Habitat and habit. B. Joint habit. C. Spine cluster. D. Bud. E. Fruits. F-G. Flowers. H. Roots.

downriver and upriver from the *C. emoryi* populations (Fig. 3; A), but this is not yet scientifically documented.

Distinguishing characteristics of *Corynopuntia emoryi* include (1) habit of open clumps to mats, (2) roots diffuse, filiform, adventitious, and generally of a fragile or delicate nature lacking a papery-cork epidermal layer, (3) stems erect, in larger mats without clear above-ground central point of origin; 4) joints clavate, laterally-growing, firmly-attached, long, robust, (5) central spines flattened (not angled abaxially), shorter/sparser relative to joint size in comparison with other Big Bend species, one main central spine and three smaller subcentrals, all evenly colored tan with no white, (6) radial spines essentially equal in color to central spines, and (7) filaments green. Specimens of Big Bend area plants are less robust and spiniferous in comparison to material of the same species from Arizona and New Mexico. While not typically confused with other CSC species, one specimen (consisting of two individual joints) had been to that point misidentified as *C. schottii* (*BER 112*).

CORYNOPUNTIA GRAHAMII (Engelm.) F.M. Knuth, Kaktus ABC, 116. 1935. *Opuntia grahamii* Engelm., Proc. Amer. Acad. Arts 3: 304. 1857. *Opuntia schottii* var. *grahamii* (Engelm.) L.D. Benson, Cact. Succ. J. (Los Angeles) 41: 124. 1969. *Grusonia grahamii* (Engelm.) H. Rob, Phytologia 26: 176. 1973. **LECTOTYPE** (Bárcenas et al. 2012): **USA**. **Texas**. [El Paso Co.]: Sandy soil in the bottom of the Rio Grande, near El Paso, and for a distance of about 100 miles along the river, 1851, *C. Wright 10* (MO sheet 2015356!; epitype: *Palmer 386* MO sheet 2511550; isoepitypes: K, NY, US; other material: *Wright s.n.* GH!). GRAHAM'S CLUB CHOLLA. Figs. 18-19.

Corynopuntia grahamii occurs in sandy to rocky limestone soils across its range and often in soils with some clay content in the central/southern Big Bend region. Populations of *C. grahamii* in Brewster and Presidio counties are frequently mixed with or closely associated with *C. aggeria* (Fig. 3; B). *Corynopuntia grahamii* is marginally associated with *C. densispina* in a limited area of southern Brewster County. *Corynopuntia grahamii* and *C. schottii* appear to be sympatric in eastern Brewster County (*MSA 977, 981* MICH); both species are sympatric with *C. aggeria* in Mexico near Cuatro Cienegas, nearly 325 km directly south from the area of sympatry in eastern Brewster County (*DJP 5279, 5714; MAB 12817* ASC). Plants of *C. grahamii* across their geographic range are consistently tetraploid and exhibit a high percentage of sterility (e.g., *JF 694, 2342, 2352*; Appx. A, C).

Plants of *Corynopuntia grahamii* with typical morphology, i.e., individuals similar to those found near the type locality, are readily distinguished from other species by (1) habit of open clumps to small mounds, (2) roots of conic-fusiform tubers with shedding papery-cork epidermal layer, (3) stems erect-ascending, emanating from a clear, above-ground central core of the plant, (4) joints ovate, apically-chaining, readily-disarticulating, openly-associated, (5) central spines terete, with iridescent bulbous bases, colored pink to red-brown, saturated with no white, (6) radial spines six or more, terete, white, and with differently-colored bulbous bases, and (7) filaments green.

In *Corynopuntia grahamii*, the higher number of central and radial spines combined with generally smaller joints can give the plants a particularly bristly appearance making it difficult to see the epidermal surface of joints. Flowers are usually yellow; rose to salmon-pink tepals are an uncommon but consistent feature in populations across the range. During the spring season, new joint growth in *C. grahamii* develops at the same time as buds are produced in populations of *C. aggeria*; in mixed populations the phenologic stages can be an additional identification aid.

Corynopuntia grahamii in the Big Bend region are often more robust than the typical morphology found near the type locality (Fig. 19). Robust Big Bend *C. grahamii* have central spines –– terete to flattened above and angled below –– that are often white-streaked and/or with deeper red

Figure 18. *Corynopuntia grahamii*. Clockwise from top left. A. Habitat and habit; note apically-chaining, erect stems. B. Roots and joint shape. C. Spine cluster. D. Bud. E. Typical bloom with yellow tepals. F. Occasional pink-tepal bloom. G. Stem/joint habit of robust Big Bend form; note fewer central spines and radials but consistent apical chain and globose joint shape.

Figure 19. Morphologic comparison between western *Corynopuntia grahamii* (left) and Big Bend area (right) plants. Note smaller joint size, denser tubercles, higher spine number of the western morph and the increased glochids, fewer radial spines, and more robust habit of the Big Bend morph.

coloration as opposed to the saturated, paler mauve/peach-pink color consistently seen in western populations. Most Big Bend *C. grahamii* also tend to have fewer spines (≤ 6 centrals, ≤ 4 radials), may show more growth from lateral areoles, and may exhibit some atypical clavate joint morphology, while maintaining ease of disarticulation, tuberous roots, apically-chaining obovate joints, and tetraploid chromosome number (e.g. *JF 2415, AMP 6152*). Two *C. grahamii*-like collections (*JF 2325, JF 1558/MAB 17814*) were documented as tetraploids and have typical robust morphologies as seen in the Big Bend region, but roots were scraggly and diffuse, not containing any tubers. The typical morphology of smaller joints and more numerous spines can be found in the Big Bend –– it is just not as widespread as the robust morph.

CORYNOPUNTIA SCHOTTII (Engelm.) F.M. Knuth, Kaktus ABC, 114. 1935. *Opuntia schottii* Engelm., Proc. Amer. Acad. Arts 3: 304. 1857. *Grusonia schottii* (Engelm.) H. Rob., Phytologia 26: 176. 1973. **LECTOTYPE** (Benson 1982): **USA**. **Texas**. [Val Verde Co.:] Arid hills near the Rio Grande, between the San Pedro and Pecos rivers, 1853, *A. Schott s.n.* (MO sheet 2015355!; isotype: NY sheet 00688043!; other original material: *Schott 80*, F!; *Schott s.n.*, NY sheet 00688042! (> *C. grahamii*); *Schott s.n.*, NY sheet 00688042!; *Wright 227*, MO). CLAVELLINA. Fig. 20.

Corynopuntia schottii occurs most abundantly in deeper, loamy-silty soils, although it can also be found in rockier locations with shallower soils. The only co-occurring species is the marginally sympatric *C. grahamii*, occurring at the extreme western extent of the *C. schottii* range both in the

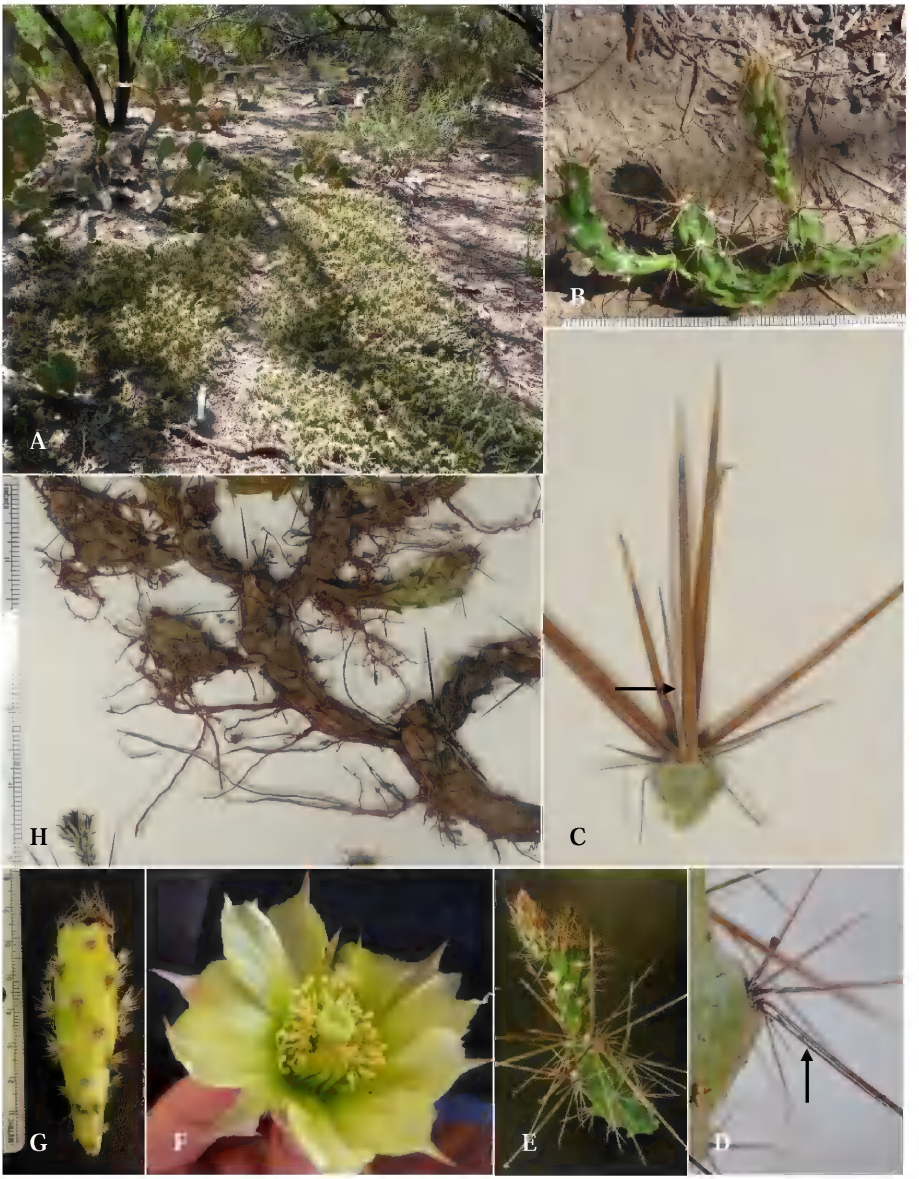

Figure 20. *Corynopuntia schottii.* A. Habitat and habit (south Texas). B. Stem habit; note bud origin on medial joint. C. Spine cluster; arrow indicates diminutive subcentral; note origination at base of larger, main central. D. Spine cluster, profile; arrow highlights tight association of diminutive subcentral and adaxial central spine. E. Bud proliferation. F. Flower. G. Ripe fruit. H. Root habit.

USA (Fig. 3; B) and Mexico, although *C. aggeria* was collected within 10 km of a *C. schottii* population at Cuatro Cienegas, Mexico (*DJP 5714; MAB 12817* ASC). Plants of *C. schottii* are hexaploid at both the eastern and western USA extents of its range.

Aside from chromosome number, *Corynopuntia schottii* is quickly distinguished from other species by (1) a habit of ground-hugging stems that can form dense, extensive mats, (2) roots diffuse, filiform, adventitious, generally more fragile or delicate without shedding papery-cork epidermal layer, (3) stems prostrate and creeping, developing into mats without an obviously central, above-ground origin, (4) joints clavate or J-shaped, laterally-chaining, readily-disarticulating, (5) central spines flat/angled abaxially, colored copper/red/dark-brown with many mature spines having white margins and abruptly narrowing at the barbed tips, medial subcentral central spine diminutive and lighter in color than other central spines, (6) radial spines lighter in color than centrals, and (7) filaments green. When compared side-by-side, typical stems of *C. schottii* and *C. grahamii* are truly distinctive based on the above listed characters (Fig. 21).

Figure 21. Joint comparison between *Corynopuntia schottii* (left) and *C. grahamii* (right). Note in *C. schottii*: (1) clavate/J-shaped joint, (2) broad, ill-defined tubercles, (3) relatively long, copper-colored, erect main central spines in the top third of stem areoles, (4) descending subcentral spines, (5) few radials, (6) few glochids, (7) abundant, persistent spine sheaths, and (8) abundant bristle spines at the pericarpel rim. This contrasts with *C. grahamii*: (1) ovate/globose joint shape, (2) laterally-compressed, inflated tubercles, (3) thinner (terete) peach-colored, central spines in at least the top half of stem areoles, (4) lack of subcentral spines, (5) numerous radial spines, (6) abundant glochids, (7) fewer and less obvious persistent spine sheaths, and (8) fewer pericarpel-rim bristle spines.

Additional distinct characters apart from all other species of the CSC include (1) stem tubercles commonly appearing deflated when dry (Fig. 6; B), with flattened abaxial profiles and not laterally compressed when turgid, (2) flower buds appearing on joints two or three more basal than the terminal joint of a stem as opposed to the four other species where buds appear on only terminal joints, buds also commonly proliferating from pericarpelar areoles (not documented in the other CSC species), and (3) pericarpal rim areoles having longer conic leaves and more bristle spines than in the other four species. The fruits of *Corynopuntia schottii* are similar to those of *C. emoryi* (and differ from *C. aggeria*, *C. densispina*, and *C. grahamii*) in that they turn yellow when mature, are more elongate-fusiform shaped, less tuberculate, and have globose areoles with radiating glochids. However, as noted in Powell and Weedin (2004), unlike in *C. emoryi*, mature fruits of *C. schottii* persist on the plants often into the next reproductive season.

Some *Corynopuntia schottii* plants collected in the western part of its range (e.g., Terrell Co., *AMP 6248, BER 107, JF 2406, Lee 30*; Val Verde Co., *JF 2404*) show slightly modified stem and root morphology from the more typical traits encountered in south Texas. Modified traits of the western plants include (1) roots of smaller, clumpy plants slightly thickened and centralized, neither tuberous nor filiform, (2) both ovate and clavate/J-shaped joints, and (3) joints with inflated tubercles and joints with deflated tubercles occurring in the same individual.

Putative hybrids (see map, Fig. 22)

Corynopuntia aggeria × *C. grahamii*

Putative hybrids between *Corynopuntia aggeria* and *C. grahamii* were found in numerous locations across the southern Big Bend area (Fig. 22) and several proved to be sterile, i.e., either producing malformed meiocytes, or meiocytes entirely lacking, (e.g., *JF 2334a, 2341a, 2341b, 2359, 2368b*). One putative hybrid of *C. aggeria* and *C. grahamii* was triploid (*JF 2334*). The putative *C. aggeria* × *C. grahamii* hybrids do not seem to fit one consistent morphologic profile; instead each individual displays varying degrees of parental traits. For example, one individual encountered (*JF 697*) has clavate, laterally-growing joints that easily disarticulate plus terete, dark-red central spines; another (*JF 2353b*) has ovate, robust joints that grow both laterally and apically, sometimes disarticulating with more effort than is typical for *C. grahamii*, with 3 or 4 short flat stout white central spines and only one pair of radials, and perhaps even pink tepals and red filaments. Frequently the tuberous roots of putative hybrids of *C. aggeria* and *C. grahamii* appear to be more slender than typical of either parent species. Flowers with red filaments and abundant pollen, as well as flowers with green filaments lacking pollen are both found in putative hybrids. Near the Maverick Road in BBNP and in the Cedar Springs area of Terlingua Ranch, plants with red-filamented flowers had fruits that seemed to lack developing seeds, while plants with green-filamented flowers had maturing fruits with well-formed seeds. Red filaments also appear to be associated with more robust plants that have fewer overall spines, whereas green filaments seem to be associated with smaller-sized joints.

Corynopuntia aggeria × *C. densispina*

One chromosome-documented putative hybrid from the Ernst Tinaja area, BBNP (i.e., n=14-16; *JF 635*), demonstrates the following mixed traits: (1) 4–6 central spines broader than *Corynopuntia densispina* and similar to some robust *C. aggeria* morphotypes, (2) primary radial spines longer than in *C. aggeria* but shorter than typical in *C. densispina*, (3) tuberous roots, (4) unusually abundant glochids at the apex of terminal joints, and (5) bud production much earlier than in surrounding *C. densispina*. Early bud production was how this putative hybrid individual was initially noticed. Other putative hybrid vouchers (*JF 702, 703*) were made from a mixed population of *C. densispina* and *C. aggeria* in the Solis area, BBNP, with various buds yielding chromosome formations that suggested triploidy and tetraploidy with multivalents.

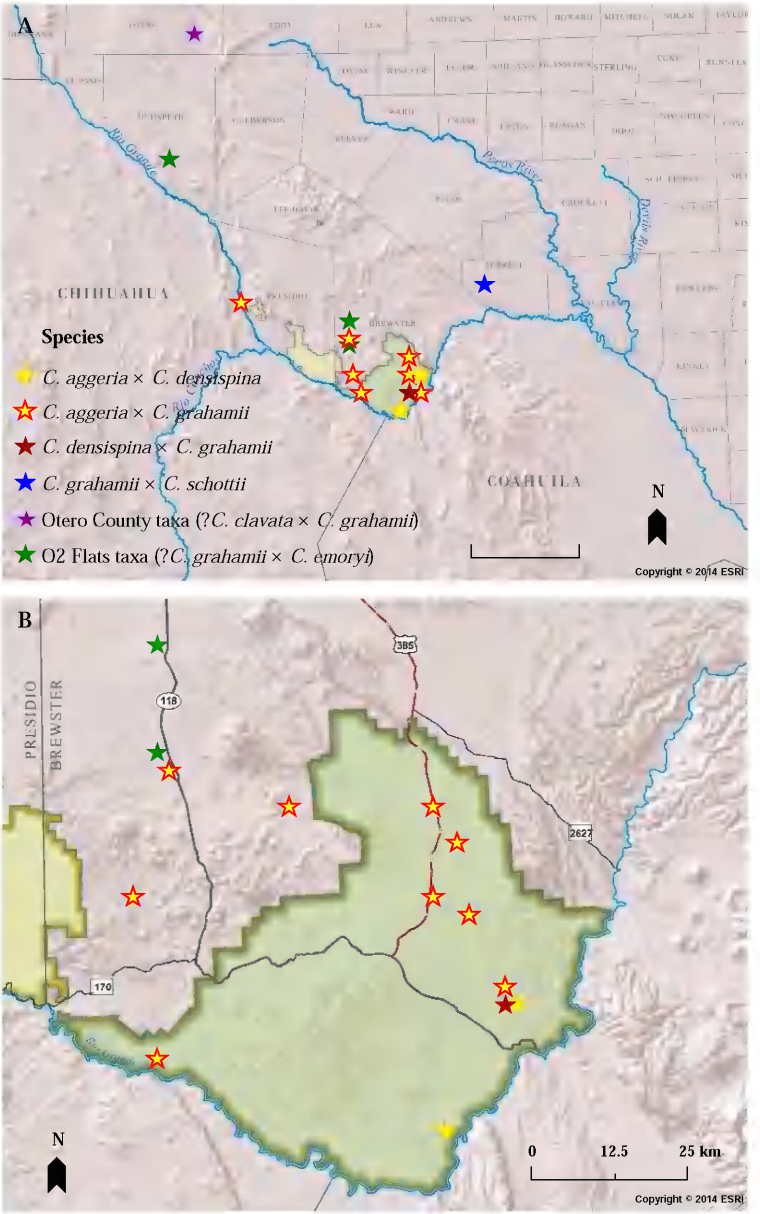

Figure 22. Hybrid voucher collections of *Corynopuntia schottii* complex species. A. Texas, adjacent New Mexico, adjacent Mexico. B. Big Bend National Park, Texas, and environs.

Corynopuntia densispina × *C. grahamii*

Individuals were collected from two different locations within 1 km of each other (*JF 2355, 2390, 2391*); both locations were also in the vicinity of populations of both parent species. Putative hybrids of *Corynopuntia densispina* and *C. grahamii* stood out as clearly distinct, in comparison to the surrounding plants (individuals of *C. densispina*), by virtue of the following mixed traits: 1) thickened taproots as well as abundant, straggly, diffuse roots, 2) robust joints, both clavate and ovoid shaped, with most growing apically and disarticulating relatively easily, 3) long, flat, white (one individual with terete and mauve) central spines, 4) relatively long 1° radial pairs, 5) protruding basal areoles with radiating glochids, 5) striking fuchsia-pink flowers (*JF 2391*).

Corynopuntia grahamii × *C. schottii*

The collection made in Terrell County, Texas (*JF s.n.*) is within the range expected for *Corynopuntia schottii* (Fig. 1 B) and slightly further east than expected for *C. grahamii*. The voucher displays mixed morphologic characters. Traits reminiscent of *C. grahamii* include (1) ascending, apically-chaining stem habit, (2) ovate joint shape, (3) inflated tubercles, and (4) terete central spines. Traits reminiscent of *C. schottii* include (1) diffuse roots, (2) lateral growth, (3) flat, deep-red-colored central spines, (4) diminutive subcentral spines, and (5) bud proliferation. The one bud collected for chromosomal analysis was meiotically sterile.

Unidentified populations of *Corynopuntia* in the Big Bend region (see map, Fig. 22)

Brewster and Hudspeth counties, Texas

Several specimens collected Brewster County, in Green Valley ("O2 Flats," ca. 42 miles south of Alpine), do not fit the profile of any one CSC species but rather a mixture of traits attributable to four of the CSC species: *Corynopuntia aggeria*, *C. grahamii*, *C. emoryi*, and *C. schottii*. Two recent collections (*CJ 285*, *310*) align most closely with *C. grahamii* in their (1) cylindric joints, (2) thin, terete, papillate, saturated-peach central spines, (3) multiple radials, and (4) bulbous/iridescent spine bases. However *CJ 285* and *310* also exhibit subcentral spines (as in *C. emoryi* and *C. schottii*) as well as diffuse roots (as in *C. emoryi* and *C. schottii*), tightly attached stems (as in *C. aggeria*, *C. emoryi*), and some lateral growth (as in *C. aggeria*, *C. emoryi*, *C. schottii*).

An additional recent collection in the same area (*CJ 364*, Fig. 23) includes mixed characters suggesting *Corynopuntia aggeria*, *C. grahamii*, and *C. emoryi*: (1) thick, clavate-cylindric joints, (2) large tubercles similar to *C. emoryi*, (3) wide, flat areoles with short, felt-like wool as in *C. emoryi* or *C. schottii*, (4) central spines of varying shapes/aspects including (a) flat, erect, and robust like *C. schottii*, (b) some areoles with upper centrals terete and one main, flat lower central like in *C. emoryi*, and (c) some central spines streaked with white like in *C. aggeria*, but with most colored a saturated dark red-brown seen in *C. grahamii* and *C. schottii*, and (5) numerous radials like in *C. grahamii*. The collection *CJ 364* also exhibits a novel trait as yet unobserved in CSC species: at least five subcentral spines — one medial subcentral and two pairs of lateral subcentrals — which is more than the one pair of lateral subcentral spines known in *C. emoryi* and *C. schottii*. The position of these additional subcentrals are analogous to the pattern of 1° and 2° pairs of radial spines (Fig. 9) but are clearly situated in an intermediate aspect overlying the surrounding radials yet underneath the main central spines (Fig. 23 C).

Historic collections from the O2 flats (*MSA 1174, 1304* MICH) similarly show affinity to multiple CSC species, mostly strikingly in that some central spines have white margins as seen in *Corynopuntia schottii*, and in that the radial spines have bulbous and iridescent bases as in *C. grahamii* (despite their flattened, not terete, shape). Also present in *MSA 1174* and *1304* are decurved main central spines and central spines streaked with white, thus far known only in *C. aggeria*/*C. densispina*. A similar mixed-character specimen from Hudspeth County, south of Sierra Blanca (*KHS 4123* UNM), sharing characters from what could be considered the "*C. schottii*/*C. emoryi* cohort"

Figure 23. Unidentified *Corynopuntia* from the O2 flats, Brewster County, Texas (*CJ 364*). A–B) Habit. C) Spine cluster; arrows indicate the relatively robust yet still diminutive subcentral spine, plus 1° and 2° subcentrals. The position of these subcentrals is clearly intermediate, overlaying the white, thin radial spines and underneath the thicker, more robust main central spines.

(one flat lower central spine, terete uppers, subcentral spines) as well as the "*C. grahamii*/*C. aggeria* cohort" (protruding basal areoles, saturated-papillate, terete, upper centrals with bulbous iridescent bases, abundant glochids).

Otero County, New Mexico

A second unidentified *Corynopuntia* population consists of several collections from southeastern Otero County, NM (*GW 3809A, 3809B, 3811, 3843, s.n./UNM 67866, s.n./UNM 86335* UNM). These collections have characters known from *C. clavata* in addition to some of the CSC species (Fig. 24). Diffuse roots, robust habit, laterally chaining clavate stems, and kinked or twisted radials suggest *C. densispina* or *C. aggeria*. Additional characters suggest *C. clavata*, known from northern Otero County, and *C. grahamii,* known from SW Otero County (e.g., *GW 3829* UNM), and possibly *C. schottii*. The specimens do not consistently exhibit the exact same morphology but generally the *C. clavata* characters include (1) diffuse roots, (2) laterally chaining, robust, short-clavate joints, (3) robust, numerous, flat/broad, longitudinally striate, whitish central spines with only one main central spine being the widest and whitest, (4) robust radial spines, and (5) long, robust glochids. Characters suggesting *C. grahamii* include (1) protruding basal areoles, (2) saturated, peach-colored central spines, (3) terete, upper central spines with bulbous iridescent bases, and (4) numerous radial spines. Characters that could be considered *C. schottii* traits include strongly J-shaped clavate joints and central spines that abruptly narrow at the tips, though these traits are also seen in *C. clavata*.

DISCUSSION

The current study significantly expands the breadth and depth of all CSC species concepts, and helps resolve the persistent confusion between the CSC species. Perceptions of widespread intermediacy, genetically-mediated variability, and poor/incomplete/limited study specimens all contributed to the historic lack of clarity. The variation in characters that was once attributed to widespread hybridization between *Corynopuntia grahamii* and *C. schottii* was provisionally explained by the discovery of a separate species, *C. aggeria*, and is now well documented through broadly based field observations and vouchered chromosome counts. *Corynopuntia aggeria* is a distinct, consistently diploid species displaying extremely varied morphology both within and between populations. The lack of clarity between species concepts was likely due not only to the plasticity of *C. aggeria* across its range but also the now-documented and apparently widespread introgression of *C. grahamii* with *C. aggeria*. Moving east from its type locality, the progressively more robust morphology of *C. grahamii*, in addition to multiple instances of mixed populations, true hybrid morphologies, and triploid and tetraploid counts within populations of *C. grahamii*, provide evidence that the variations are not environmental nor are they the result of a plastic phenotype as in *C. aggeria*. Hybrids are known between other species but in very localized areas and are unlikely to have contributed to the historic perception of widespread intermediacy.

Viewing plants in isolation, especially prepared specimens, may have increased the possibility of confusion between some species. The original published description of *Corynopuntia aggeria* (Ralston & Hilsenbeck 1989) states the filaments as green. The type specimen (*MSA 856* MICH) does not contain floral material; the original type description (Anthony 1956) states filament color as red. It is not clear whether the Ralston and Hilsenbeck description of filament color was derived from subsequent collections or field observations. During the current study, all filaments in *C. aggeria* observed were pink at minimum, but most were deep maroon-red. Bárcenas (2004) reported that the majority of *Corynopuntia* [*Grusonia*] species, including the five CSC species, have red stigma lobes. However the coloration noted by Bárcenas may have been an artifact of the drying process; during the present study all live flowers of CSC species observed in the field or in cultivation had yellow or cream colored stigma lobes, which in the subsequent dried specimens actually appear light pink.

Figure 24. Unidentified *Corynopuntia* from the Brokeoff Mountains, southeastern Otero Co., New Mexico. A-B) *Weins 3809* UNM: few, short central spines including one broad, main central spine, plus terete, bulbous-based upper centrals. C-D) *Weins s.n./UNM 67866* UNM: numerous, long central spines with iridescent bulbous bases.

Lack of context appears to be why *Corynopuntia densispina* was for so long disregarded as a distinct species. Two specimens collected by Margery Anthony in 1948 were identified at the time as *C. schottii* (*MSA 273, 1137*). They are in fact *C. densispina* and are now considered the first known collections of that species. Commingling these distinct individuals into one broadly inclusive species concept helped propagate much subsequent taxonomic confusion throughout the CSC history.

Superficial similarities, namely clavate joint shape and diffuse roots, do exist between *C. densispina* and *C. schottii*. This likely contributed to the fact that *C. schottii* has been widely cited as a tetraploid (Yuasa et al. 1973; Weedin & Powell 1978; Pinkava et al. 1985; Ralston & Hilsenbeck 1989; Weedin et al. 1989; Powell & Weedin 2001, 2005; Pinkava 2002). After most of these voucher specimens were reassigned based on improved morphologic and chromosomal understanding, by 2004 there was only one remaining chromosome count attributed to *C. schottii* (Powell & Weedin 2004; *DOK 53*). Now, the morphology displayed by that remaining tetraploid voucher specimen, bolstered by chromosome counts showing *C. schottii* to be hexaploid, both suggest the voucher *DOK 53* is actually *C. densispina*. Even if disregarding the difference in ploidy level, the clear distinctions involving disarticulation, spination, habitat, and distributions between *C. densispina* and *C. schottii* eliminate the possibility that they are the same species.

Future Research

As a result of the present study, more coherent definitions for CSC species now exist to help guide future explorations of these and related taxa within *Corynopuntia*. The details of morphology, habitat, distribution, and chromosome number discussed above already clearly demonstrate the distinctness of each species. Many unresolved issues, however, were uncovered in the course of study, including potentially new identifying characters, taxa with unknown chromosome numbers, and possible new species/taxa. These all warrant further study; several topics are offered below to inspire continued study of the CSC and the *Corynopuntia* genus as a whole.

Spine surface characteristics. Bárcenas (2002) and I note that the spine surface character consistently differs between some CSC species, from the abundantly farinose surfaces of *Corynopuntia aggeria* and *C. densispina* to the variously ridged surfaces and appressed/sclerified trichomes in *C. emoryi* and *C. grahamii*, as opposed to the relatively smooth spine surfaces in *C. schottii*. Similar interspecific differences in epidermal micro-morphology have been documented in at least one other Cactaceae genus (*Turbinicarpus*, Mosco 2009). Additionally, I have observed that the rudimentary spine sheaths, occurring only at the tips of central spines, persist much longer on *C. grahamii* and *C. schottii* than in the other three CSC species. SEM analysis has been used to demonstrate some differences in spine morphology between Opuntioid (s.l.) genera (Robinson 1974), but the study lacked infrageneric comparisons and analysis of central spine tips. Perhaps targeted morphologic analysis within *Corynopuntia* species would not only better document the above-mentioned micro-morphological differences but explore a possible structural basis for my extensive anecdotal experience that both glochids and central spines of *C. grahamii* and *C. schottii* puncture and lodge more readily and securely into shoes and skin than do glochids and central spines of *C. aggeria*, *C. densispina*, or *C. emoryi*. More robustly-barbed spine tips in readily disarticulating species would be consistent with adaptations for increased effectiveness of vegetative propagation via mammalian vectors, especially considering *C. grahamii* and *C. schottii* showed the lowest pollen stainability percentages (i.e., lower fertility) among CSC species in the current study.

Disarticulation. Ease of joint detachment has long been an inconsistently recorded and/or appreciated character state for CSC species. The manifestation of this character appears to be consistent across USA populations of CSC species, but perhaps not in Mexico. According to Davide Donati (pers. comm.), there may be a seasonal or perhaps rainfall-correlated relationship affecting disarticulation in some species.

Secondary compounds. Freshly cut stems of *Corynopuntia aggeria* release a strong odor which was not observed in freshly cut stems of other CSC species (JF pers. observ.). Many different chemicals are known in Cactaceae and there seems to be some level of differentiation between alkaloids found in some *Corynopuntia* species (Trout 2014). In one example, mucilage flavor was cited as a character distinguishing *Corynopuntia* from *Grusonia* and *Cylindropuntia* (Hamilton 1970).

Perhaps a targeted study of secondary compounds of all *Corynopuntia* species would help elucidate infrageneric relationships.

Extra-floral nectaries/spine secretions. Extra-floral nectaries (EFNs) have been observed in *Corynopuntia emoryi*, *C. invicta*, and *C. wrightiana* as well as spine tip secretions — and associated interest by ants — in *C. emoryi* and *C. schottii* (Felger et al. 2014). In my Alpine, Texas, research collection I also observed liquid droplets at the tips of emergent central spines in *C. emoryi* and *C. schottii* (Fig. 25; A-C). Similar to the related reports in Felger et al. (2014), I also observed in my collection non-native rover ants (*Brachymyrmex patagonicus*), multiple times during two spring seasons (2014-15), visiting areoles of new stem growth and performing "spine grooming" behavior (i.e., rapid paddling of antennae) on the tips of emergent central spines of *C. schottii*, *C. emoryi*, *C. aggeria*, and of *C. aggeria* × *C. grahamii* and *C. grahamii* × *C. schottii* putative hybrids (Fig. 25; D-E). In south Brewster County (near Lajitas and in Big Bend National Park, June 2015) I observed workers of a different, presumably native, ant species in abundance on in situ *C. aggeria* plants, visiting and performing spine grooming behavior in areoles of newly growing stems. In addition, in my Alpine research collection, I observed over two seasons (spring 2014, 2015) numerous prickly pear cactus bug nymphs (*Chelinidea vittiger*) in and among the tubercles of the above-mentioned putative hybrids, often with their probosci embedded in the areolar wool (Fig. 25; F).

Breeding systems. Widespread lack of pollen and/or withered anthers in *Corynopuntia grahamii*, in addition to lack of fruits across its range, suggests reproductive dysfunction rather than a nascently-evolving cryptic breeding system. However cryptic fertility cannot be ruled out in *C. schottii* or *C. emoryi*. In the south Texas *C. schottii* populations, fruits are uncommon yet still present in the densely-matted, extensive colonies. No clear pattern of perfect and pistillate-flowered individuals was immediately apparent in the field, but pollen stainability did seem to segregate evenly to higher and lower levels in *C. schottii* (Fig. 2), suggesting a possible evolution toward differential floral fertility. One *C. emoryi* specimen examined (*MAB 11638*) includes flowers with no pollen (Appx. C) but also a fruit with seeds; a separate *C. emoryi* specimen (*AZ 2348*) includes flowers with abundant and high-staining pollen (Appendix C) as well as label data noting fruits were observed in the population. These inconsistencies may indicate more than simple sampling error. Subdioecy is correlated with polyploidy and is known in Cactaceae (Ashman et al. 2013). Recently, another report was made of gynodioecy in *Cylindropuntia* (Baker & Cloud-Hughes 2014), adding to the five other gynodioecious species in the genus (Rebman 1998); as yet gynodioecy is undocumented in *Corynopuntia*. Different levels of fertility within a population would be expected especially in the hexaploid *C. schottii* but data collection for the current study was not designed to draw definitive conclusions regarding fertility levels. The possibility of cryptic dioecy or agamospermy in both *C. schottii* and *C. emoryi* should be investigated.

Chromosomal studies. The unexpected discoveries of various ploidy levels in Big Bend *Corynopuntia* populations should encourage more attention to this line of inquiry, both to support investigations into regional polyploid evolution as well as to further elucidate lesser understood, regional *Corynopuntia* species. The Mexican *C. vilis*, known from Coahuila to San Luis Potosí, is uncounted. Highly similar in features to the tetraploid *C. grahamii*, *C. vilis* is distinguished most obviously by its purple-pink flower. This makes the occasional but consistent presence of salmon-orange pink flowers in typical *C. grahamii* populations across its USA range especially intriguing. Flower color and extreme morphologic similarity suggest the possibility that *C. grahamii* is an autotetraploid derivative of a diploid *C. vilis*. The Mexican diploid *C. moelleri*, despite being regularly included as an extant member of the Chihuahuan Desert club cholla cohort (Bravo-Hollis 1978; Anderson 2001; Bárcenas 2004; Hernández et al. 2004; Hunt 2006), had long been documented by only one chromosome count in the literature (Pinkava & Parfitt 1982) and with only a brief literature description based solely on what could be considered unrepresentative, cultivated material

Figure 25. Extra-floral nectaries and spine secretions in Big Bend *Corynopuntia*. Arrows indicate apparent spine-tip secretions from emergent central spines in A) *C. emoryi* (*PM s.n.*) and B–C) *C. schottii* (*TP s.n.*). D) *Chelinidea vittiger* nymph with proboscis in areolar wool of *C. grahamii* (*JF 2302*). E–F) *Brachymyrmex patagonicus* "grooming" spine tips with antennae on *C. grahamii* (*JF 2302*). 9 July 2014, cultivated plants in pots, Alpine, Texas.

(Bravo-Hollis 1978; Wright 1932). Donati (2011) reexamined the taxon in the field and concluded via chromosome analysis, morphology, and geography, that *C. moelleri* is a well defined species that — despite having various morphotypes — does exclude character overlap with especially *C. bulbispina*, yet is similar in aspect to the northern diploid *C. clavata*. The existence of uncounted morphotypes in *C. moelleri*, as well as its sympatry and past confusion with various other *Corynopuntia* species including the little known and uncounted *C. guccini* and *C. nigrispina* (Donati 2010, 2012), support the need for further study.

Hybridization. Unreduced gametes are believed to account for most of the origins of polyploid *Opuntia* (s.l.) (Pinkava et al. 1998) and are implicated in *Cylindropuntia* hybridization (Baker & Pinkava 1987). Evidence for the existence of unreduced gamete production in Big Bend *Corynopuntia* is suggested by multiple observations: (1) the existence of triploid individual within a *C. densispina* population (*JF 635*), (2) observation of heteromorphic bivalents and univalents in samples from a *C. densispina* population, (3) a suggested triploid meiotic pairing in a sample from a mixed population of *C. aggeria* and *C. densispina* (*JF 703*), (4) observations of two sizes of pollen grains within a single pollen grain sample, most often noted in samples from *C. aggeria* and *C. densispina*, and (5) a pentaploid *C. grahamii* individual (*JF 2416*). The formation of autopolyploids such as *C. densispina* via the triploid bridge mechanism (Ramsey & Schemske 1998) is a likely scenario, where triploids form in a diploid population by the production of an unreduced gamete and then either self-fertilize or backcross to a diploid, either of which results in a tetraploid.

The Big Bend area, with its high desertic temperature extremes and frequent drought conditions, may be a particularly well-suited location for the production of unreduced gametes as they occur more frequently as a result of environmental stress (Ramsey & Schemske 1998). There are now more vouchers suggesting gene exchange between Big Bend *Corynopuntia* species, but the true extent of hybridization and/or introgression between *C. grahamii* and *C. schottii* is unknown. So too is the extent and/or mechanism and significance of the apparent widespread introgression between *C. grahamii* and *C. aggeria*. Additionally, unidentified specimens (discussed below) that do not align with any one known species concept raise the distinct possibility of additional hybrid evolutions; these taxa require further study.

Novel taxa. The more robust character descriptions developed herein for the CSC species resulted in several specimens defying definitive identifications. The collections from mid-Brewster and northern-Hudspeth counties show affinities to multiple CSC species, and those from the Brokeoff Mountains in southeastern New Mexico contain characters suggestive of *C. clavata* and *C. grahamii*. In addition, I encountered two unusual *C. emoryi* specimens from southeastern Arizona (*Puente 1624*, *Rebman 1850*, DES) that suggest an affinity to *C. schottii* in that the joints were strongly J-shaped, with long spines relative to the shorter/smaller joints (the opposite is true in typical *C. emoryi*), as well as copper-colored central spines with white margins. Further documentation of these mixed-morphology populations will help inform possible evolutionary connections between these species. Hybrids have not only been documented in areas disjunct form parental taxa (Pinkava et al. 1998) but taxa resulting from the introgression of three parental genomes is not impossible (Soltis & Soltis 2009). Discoveries of as-yet unknown taxa, including situations similar to the long-unacknowledged *C. densispina*, are a significant possibility (e.g., Donati 2014; Nesom 2015) as more of the geographic range of the genus is explored and more extant specimens are reviewed, utilizing the most up-to-date species characterizations.

Biogeographic context, evolutionary relationships. The true relationship between CSC species and Mexican *Corynopuntia* is unknown. Newly described species like *C. guccini* from southern Coahuila with its striking red flowers (Donati 2010), as well as new data (Donati 2011) that enrich the species concept of *C. bulbispina* and re-energize the protologue-only concept of *C.*

agglomerata (Berger 1929), are exciting additions to the regional pool of *Corynopuntia* genomes. Further, the similar morphology of the latter two species to *C. grahamii* and *C. vilis* (ovate joints, tuberous roots, terete spines) suggest some level of genome connection. An additional indication of possible gene exchange involves the occurrence of red filaments. In the USA populations of *Corynopuntia*, maroon-red filaments are a true, consistent character of only *C. aggeria*. Fully maroon-red filaments are occasionally seen in *C. densispina*, but this could be considered unsurprising for an autopolyploid-derived taxon. Red filaments are also known in some individuals resembling *C. grahamii* but only in populations with robust morphologies, i.e., introgressed with *C. aggeria*. In Mexican club cholla species, red filaments are reported for *C. bulbispina* and *C. agglomerata* (Donati 2011) but apparently also as a consistent character of *C. grahamii* (Donati pers. com.).

Following the above and other character traits through populations may yet add new depth to existing species concepts as well as lead to the discovery of new *Corynopuntia* species, especially in northern Mexico where the cactus diversity is high (reviewed in Hernández et al. 2004) and geographical rarity is common (Hernández & Gómez-Hinostrosa 2005; Hernández et al. 2010). There, habitat divergence and genetic isolation results from regional climatic patterns and topographically separated basins (Hernández & Bárcenas 1995), though area biodiversity was likely initially influenced by virtue of being an environmental refugium during the last glacial maximum (Van Devender 1986, 1990; Betancourt et al. 1990; Fenstermacher et al. 2008).

Similarly, the southwest desert of the USA has also been suggested as a Pleistocene refugium –– and as such serving as a hub for post-glacial expansion of *Opuntia* (s.s.) diversity (Majure et al. 2012b, c). Recalling some *Opuntia* (s.l.) species' propensity for disarticulation, this expansion of range and/or diversity may have been aided by the movements of Pleistocene megafauna (Majure 2012c) as well as humans and related domestic animals during their long history of migration across the northern Chihuahuan Desert region (Keller 2005). Perhaps the CSC is a young, localized remnant of the proposed post-glacial diversification event, considering the relatively small species ranges and sympatric distribution of diploid and polyploids (Stebbins 1971).

Molecular systematics. There is much potential to further elucidate relationships within *Corynopuntia*. Bárcenas et al. (2011) showed resolution of two *Corynopuntia* clades, each containing a diploid — *C. parishii* and *C. moelleri*. These two clades separate well based on both morphologic and geographic qualifications. Western USA club cholla species trend towards having one main spine, numerous centrals, and less morphological distinctions between radial and central spines — incidentally all characteristics of *Cylindropuntia*. Southern/eastern species, including the CSC, have fewer central spines and distinctly different radial and central spine morphologies as well as locations in the areole. The subcentral spines of *C. emoryi* and *C. schottii* seem to exist in an intermediate state between the two otherwise-separated clades.

Bárcenas et al. (2011) did not include the other known diploids of *Corynopuntia*, *C. aggeria* and *C. clavata*, in the molecular analysis so it is still unknown if more clades may be shown in the genus. The likelihood of reticulate evolution in *Corynopuntia* poses challenges to ultimate infrageneric resolution, however methods exist to elucidate this influence (Griffith 2003). Recent, strongly field-based studies in the Opuntioideae, especially Cylindropuntiae and Corynopuntiae, are resulting in species concept revisions (Majure 2012b; Felger et al. 2014), amendments (Donati 2011), and even new species discoveries and descriptions (Rebman 2006; Donati 2010, 2011, 2012; Baker and Cloud-Hughes 2014). It is hoped that the current study provides inspiration towards more such efforts.

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Appendix A. New or previously unpublished meiotic chromosome counts for the *Corynopuntia schottii* complex. Unless otherwise indicated, counts were made by the author and/or AMP, collection localities are within Texas, and vouchers are housed at SRSC. See Methods and Materials for names associated with collector abbreviations. Symbols: † univalents observed; ‡ multivalents and/or tetravalents observed; * count by MAB; ** mitotic count, by MAB.

Corynopuntia aggeria

n = 11. USA. TEXAS. **Presidio Co.** Ruidosa/Pinto Canyon Road, *BER 130* [previously unpublished, count by BER]. **Brewster Co.** Terlingua, Saltgrass Draw, *JF 2329a, 2329b, 2329c.* Big Bend National Park: West Entrance, *JF 2330, 2332*; Glen Spring Road, *JF 409, 2321, 2322*; River Road, 22.9 mi E of Castolon, *BER 123*; River Road, Solis, *JF* 2350; Rooney's Place, *ADZ 2449*; Rt. 11: mi. 6.7, *JF 2334b*; Rt. 11 mi. 7, *JF 2353a*; Rt. 12 mi. 15, *JF 2312a, 2312f, 2314*; Dagger Flat Rd, *JF 2339*; Old Ore Rd. (OOR), Telephone Canyon trailhead, *JF 1620*; OOR, La Noria jct., *JF 2343*; OOR, Ernst Tinaja jct., *JF 640, 641*; OOR, Candelilla campsite area, *JF 630, 631, 632, 633*; Boquillas Canyon Road (BCR), flats in first mile, *JF 2351d*; BCR, N of Barker House, *JF 1574a, 1574b, 1576, 2344a, 2344b, 2344e, 2345a, 2345b*; BCR, first Boquillas overlook, *JF 1562, 1563.*

Corynopuntia densispina

n = 22. USA. TEXAS. **Brewster Co.** Big Bend National Park: River Road, Solis jct., *JF 2397b, 2399, 2212**; River Road, 1.9 mi. E of Solis jct., *JF 2349a, 2349b.1, 2349b.2, 2349d*‡, *2349d.1*‡; Old Ore Rd. (OOR), Carlotta Tinaja, *JF 32380a, 2380b, 2385, 2387*; OOR, N of La Noria jct., *JF 2382g, 2382i, 2382k*‡; OOR, La Noria jct., *JF 2392*‡; OOR, Ernst Tinaja jct., *JF 691*‡, *2393a, 2393b*‡, *2394*‡, *2395a, 2395b*; *MAB 17815 / JF 2218a*** (SRSC, ASC); OOR, Candelilla campsite area, *JF 2378, 2378b, 2378c*‡.

Corynopuntia grahamii

n = 22. USA. TEXAS. **Brewster Co.** Elephant Mtn. Wildlife Mgmt. Area: southern wildlife viewing area, *JF 2372.* Big Bend National Park: West Entrance, *MAB 17814 / JF 1558*** (SRSC, ASC); Nine Point Draw campsite, *JF 2415*; North Rosillos Road mi. 1, *JF 2338b*; Rt. 11 mi. 19.7, *JF 2336*; River Road, Gravel Pit jct., *JF 2361*‡.

n = 24 – 31. USA. TEXAS. **Presidio Co.** Marfa: Casa Piedra Rd., 36.8 mi S of Marfa, *JF 2416.*

Corynopuntia schottii

n = 33. USA. TEXAS. **Val Verde Co.** Langtry, *JF 2404*† ‡. **Starr Co.** S of Escobares, *MAB 17635 / AS s.n.** (SRSC, ASC, US). Eastern edge of Rio Grande City, *JF 2430.* **Hidalgo Co.** Mission, adjacent to The Nature Conservancy Chihuahua Woods Preserve, *JF 2434.*

Corynopuntia aggeria × C. densispina

n = 14 – 16. USA. TEXAS. **Brewster Co.** Big Bend National Park (BBNP): Old Ore Rd., Ernst Tinaja *JF 635*† ‡.

n = 16 – 22. USA. TEXAS. **Brewster Co.** BBNP: River Road, Solis, *JF 703a*‡; *JF 703b*‡. Hybrid identification based on morphological intermediacy as well as chromosome count.

Corynopuntia aggeria × C. grahamii

n = 14 – 16. USA. TEXAS. **Brewster Co.** Big Bend National Park, Rt. 11 mi. 6.7, *JF 2334c.*

n = 22. USA. TEXAS. **Brewster Co.** Saltgrass Draw, *JF 2325*; near Agua Fria Rd. entrance to Hwy 118, *JF 2360a*; Big Bend National Park, Rt. 11 mi. 7, *JF 2353.* Hybrid identification based on morphological intermediacy not chromosome count.

Corynopuntia densispina × C. grahamii

n = 20 – 22. USA. TEXAS. **Brewster Co.** Big Bend National Park, Old Ore Rd., Ernst Tinaja, *JF 2355.*

Appendix B. Previously published somatic chromosome numbers for the *Corynopuntia schottii* complex, based on the summary in Pinkava (2002) with my updated determinations indicated, see symbols below. Unless otherwise noted, collection locations are within Texas and specimens are housed at SRSC. Where relevant, species names under which the counts were originally published are included in brackets; any additional annotations are subsequently listed in chronologic order. Symbols: [1] = specimen does not exist at SRSC, location unknown, reassignment based on chromosome count; [2] = updated determination from last publication (Pinkava 2002); [3] = locality unreported in literature; [4] = corrected collection number from last publication (Pinkava 2002); [5] = locality unreported in literature, now known as "Mexico" (Govorounova, pers. com. 2015*).

Corynopuntia aggeria

22 Baker et al. 2009. **Mexico, Chihuahua.** *MAB+ 12390, MAB 15667* (ASC).
22 Pinkava et al. 1985, Baker et al. 2009. **Brewster Co.** *RDW 9714* (UTEP, ASC) [*Opuntia schottii* var. *schottii*].
22 Powell and Weedin 2001. **Brewster Co.** *AMP 5216, AMP+ 6006.*
22 Ralston and Hilsenbeck 1989. **Brewster Co.** *AMP 5216, 5383; BER 114, 118, 120, 128, 135, 136, 152.*
22 Weedin et al. 1989. **Brewster Co.** *JFW 1152* [*O. schottii var. schottii*][1].
22 Weedin and Powell 1978. **Brewster Co.** *AMP 3074a, b* [*O. schottii* var. *grahamii*][2].

Corynopuntia densispina

44 Ralston and Hilsenbeck 1992. **Brewster Co.** *BER 200* (SRSC, ASC, TEX).
44 Weedin et al. 1989. **Brewster Co.** *DOK 53* [*O. schottii*][2].

Corynopuntia emoryi

22 Yuasa et al. 1973. Y-72-402-020 [*O. stanlyi* (sic)].[3]
44 Baker et al. 2009. **Arizona, Graham Co.** *MAB 11638* (ASC).
44 Pinkava et al. 1985. **Arizona, Pinal Co.** *MAB+ 4645* [ASC, as *O. stanleyi* var. *stanleyi*].
44 Powell and Weedin 2001. **Presidio Co.** Candelaria, *AMP+ 5996*[4].
44 Ralston and Hilsenbeck 1989. **Presidio Co.** Capote Creek, *BER 113.*
44 Weedin and Powell 1978. **Presidio Co.** Candelaria, *DOK 9* [*O. stanleyi*].

Corynopuntia grahamii

44 Pinkava et al. 1985. **El Paso Co.** El Paso, *RDW 6910.5* (UTEP, ASU) [*O. schottii* > *O. grahamii*].
44 Powell and Weedin 2005. **Brewster Co.** Heath Canyon, *AMP+ 6152* [*O. schottii* var. *schottii*].

Corynopuntia schottii

44 Yuasa et al. 1973. [**Mexico**]. Y 68-402-090 [*O. shotii* (sic.)].[5]
66 Yuasa et al. 1973. [**Mexico**]. Y-72-402-019 [*O. shotii* (sic.)].[5]

C. aggeria × C. grahamii (putative)

44 Weedin and Powell 1978. **Brewster Co.** BBNP, La Noria, *JFW+ 237* [*O. grahamii, O. schottii, O. aggeria*][2].
44 Powell and Weedin 2001. **Brewster Co.** Terlingua, *GGR 93-52* [*O. schottii*][2].

*Locality unreported in original publication of count (Yuasa et al. 1973), but via a translator Yuasa was contacted and asked about the collection location of these specimens; apparently the plants were in cultivation at the Izu Shaboten Park, Ito, Shizuoka Prefecture, with original material (possibly seeds) having come from Mexico. Email conversation with Elena Govorounova, May 2015.

Appendix C. Pollen stainability data for the *Corynopuntia schottii* complex including putative hybrids.

	C. aggeria	*C. densispina*	*C. emoryi*	*C. grahamii*	*C. schottii*	*C. aggeria* x *C. densispina*	*C. aggeria* x *C. grahamii*	*C. densispina* x *C. grahamii*	*C. grahamii* x *C. schottii*
Total samples measured	37	27	5	47	24	1	42	2	1
# samples containing pollen	35	22	3	13	18	1	13	1	0
Average % stainability	69	70	77	47	56	26	43	93	0
# samples lacking pollen	2	5	2	34	6	0	29	1	1
% samples lacking pollen	5	19	40	72	25	0	69	50	100
Range in stainability %	1-97	28-94	45-96	0-87	0-94	n/a	0-98	n/a	n/a
% stained grains ≥ 70%	60	64	67	15	56	0	15	100	-
% stained grains ≥ 80%	54	41	67	15	39	0	15	100	-

Appendix D. Pollen stainability measurements of the *Corynopuntia schottii* complex. Percentages for each flower sampled per voucher are listed in brackets. Stainability was measured by the author and vouchers are housed at SRSC unless otherwise noted. Underlined collection numbers indicate chromosome number vouchers. See Methods and Materials for names associated with collector abbreviations. Symbols: n/a = pollen sterile (i.e., flower lacked pollen entirely); * = sample showed two or more sizes of pollen grains.

Corynopuntia aggeria

USA. TEXAS. **Presidio Co.** Ruidosa, 4.3 mi NE on Pinto Canyon Rd., *BER 130* [91]; Marfa, 39.5 mi S on FM 169/Casa Piedra Rd, *JF 2417* [96]*. **Brewster Co.** Lajitas, 0.5 mi. N, *AMP 6006* [94]. Terlingua, Saltgrass Draw, *JF 2327* [50], *2329a* [14], *2329b* [93], *2329c* [87], *2329d* [n/a], *2329e* [93], *2329f* [86]. Terlingua Ranch, 14 mi. E on Terlingua Ranch Rd., *BER 127* [75]. Big Bend National Park: West Entrance, *JF 2330* [93], *2332* [96]; Maverick Rd., *BER 120* [36]; River Road, 12 mi E of Castolon, *BER 128* [n/a]; 20 mi E of Castolon, *BER 152* [22]; River Road, Solis jct., *JF 2350* [88]; Glen Spring Rd. (GSR), Juniper Canyon jct., *JF 392* [33]; GSR, Black Gap jct., *JF 409* [93]; GSR, S of Glen Spring, *JF 2321* [19], *2322* [1]; GSR, N of River Road jct., *JF 2370g* [85], *2370i* [92]; Rt. 11, mi. 6.7, *JF 2334b* [77]; Rt. 11, mi. 7, *JF 2353a* [94]; Rt. 12, mi. 13.6, *BER 118* [93]; Old Ore Rd. (OOR), La Noria jct., *JF 2343* [89]*; OOR, Ernst Tinaja area, *JF 640* [27], *641* [44]; OOR, Candelilla campsite area, *JF 630* [54], *631* [42]; Boquillas Canyon Rd. (BCR), flats in first mile, *JF 2351d* [68]; BCR, N of Barker House, *JF 2344a* [58], *2344b* [97]*, *2344e* [92], *2345a* [52, 85]*, *2345b* [13, 54].

Corynopuntia densispina

USA. TEXAS. **Brewster Co.** Big Bend National Park: River Road, 5.3 mi NE of Solis Ranch, *BER 200* [73]*; River Road, Solis jct., *JF 2397b* [52], *2399* [90], *2400* [n/a]; River Road, 2.8 mi W of Glen Spring Rd. jct., *JF 2349a* [74], *2359d* [67], *2396* [n/a, 84]; Old Ore Rd. (OOR), Carlotta Tinaja, *JF 2380a* [92], *2380b* [86]; OOR, S of Carlotta Tinaja, *JF 2382g* [28], *2382i* [35]*, *2382j* [n/a], *2382k* [85], *2385* [49], *2387* [75]; OOR, N of La Noria jct., *JF 2392* [n/a]; OOR, Ernst Tinaja trailhead parking, *JF 691* [85], *2393b* [50]*, *JF 2218a/MAB 17815* [55]; OOR., Ernst Tinaja jct. area, *JF 637* [n/a], *638* [94], *2394* [53], *2395a* [72]; OOR, Candelilla campsite area, *JF 2378* [90]*, *2378b* [88], *2378c* [73].

Corynopuntia emoryi

USA. ARIZONA. **Graham Co.** 6km SW of Gila Peak, *MAB 11638* [n/a]

USA. NEW MEXICO. **Hildalgo Co.** NW of Lordsburg, 13 mi. NW of Hwy 90 jct., *AZ 2348* [96].

USA. TEXAS. **Presidio Co.** Porvenir, along the river, *BHW 47473* [n/a]; Chamber's Ranch, .6 mi N of Capote Creek, *BER 113* [45]*; Candelaria, 1.2 mi SE of village, *AMP 5996* [89]*.

Corynopuntia grahamii

MEXICO. CHIHUAHUA. 52 mi S of Ciudad Chihuahua, *DJP 13374* [87].

MEXICO. COAHUILA. Cuatro Cienegas, *DJP 5279* [0].

USA. NEW MEXICO. **Doña Ana Co.** SW base of Bishop's Cap Mtn, *AK s.n .*[n/a, n/a, n/a, n/a, n/a, n/a, n/a].

USA. TEXAS. **Hudspeth Co.** Indian Hot Springs, *GGR 98-49* [n/a]; Sierra Blanca, .5 mi S of I10 on FM 1111, *JF 2429* [n/a]. **Presidio Co.** Marfa, 36.8 mi S on FM 169/Casa Piedra Rd., *JF 2416* [65]. **Brewster Co.** Elephant Mtn. Wildlife Mgmt. Area, southern wildlife viewing area, *JF 2372* [n/a, n/a, n/a, n/a, n/a, n/a, n/a], *AMP 6291* [n/a]; Terlingua Ranch, just NW of Cedar Springs Rd. and Marathon Road jct., *JF 2420* [n/a]; Big Bend National Park: N Rosillos Road, 0.5 mi W of Rt. 11, *JF 2338a* [0], *2338b* [n/a], *2338c* [n/a]; N Rosillos Road, 1 mi W of Rt. 11, *JF 2338c* [0]; Nine Point Draw campsite, *JF 694* [33], *2337* [n/a], *2401* [52], *2415* [n/a]; Dagger Flat Road (DFR), 2.3 mi E of Rt. 11, *JF 2352* [n/a]; DFR, 5.5 mi E of Rt. 11, *JF 783* [n/a]; Rt. 11

mi. 20, *JF 695* [64]*; Rt. 11 mi. 19.7, *JF 2336* [n/a, n/a, n/a, n/a, 46, 53, 83]; River Road, 0.3 mi N of Gravel Pit jct., *JF 2346* [n/a]; *JF 2361* [n/a]; Old Ore Rd. (OOR), mid-way, *JF 2403* [44]; OOR, SW of Ernst Tinaja jct., *JF 692* [n/a]; OOR, Ernst Tinaja spur road, *JF 2354* [n/a]; OOR, at La Noria jct., *JF 2342* [n/a]; OOR, 4 mi S of N end, *JF 696* [n/a]. Heath Canyon Ranch: near La Linda crossing, *BER 111* [43]; just N of airstrip, *AMP 6152* [47].

Corynopuntia schottii

MEXICO. COAHUILA. Cuatro Cienegas, *DJP 5714* [75]*; *JL 75413* [0].

USA. TEXAS. **Terrell Co.** N of Sanderson, E of 285 on FM 2400: 13 mi., *JF 2406* [n/a]; 15 mi., *JF 2407* [n/a]; 16 mi., *BER 106* [n/a]; 17 mi., *JF 2408* [n/a], *BER 107* [n/a, n/a, 0]; 17.6 mi., *BER 108* [78]; 30 mi. S of Sheffield on Hwy 349, *SL 26* [0]. **Val Verde Co.** Langtry: *AMP 6248a* [82]; at entrance off Hwy 90, *JF 2404* [n/a, 71, 84, 94], *JF 2405* [77, 87, 93]; 1.4 mi S of Hwy 90, *BER 103* [n/a, 94]. Pandale: 13 mi. N of Hwy 90 on 1024, *BER 101* [82]; 2 mi. E of Pandale on 1024, *BER 102* [89]; 9 mi. N of Hwy 90 on 1024, *BER 100* [1]. **Starr Co.** Rio Grande City: East of downtown on Hwy 83, *JF 2430* [44]; N of Escobares, *AS s.n./MAB 17635* (SRSC, ASC, US) [30]*. **Hidalgo Co.** Mission: Chihuahua Woods Preserve, *ME s.n.* [61]; adjacent to Chihuahua Woods Preserve, *JF 2434* [64].

Corynopuntia aggeria × C. densispina

USA. TEXAS. **Brewster Co.** Big Bend National Park, Old Ore Rd., Ernst Tinaja jct., *JF 635* [26].

Corynopuntia aggeria × C. grahamii

USA. TEXAS. **Brewster Co.** Hwy 118: 0.5 mi W on Agua Fria Rd, *JF 2360a* [0, 50, 64], *2360b* [38, 69]; Terlingua, South County Rd. 8 mi. N of FM 170, *JF 2325* [59], *2368a* [n/a], *2368b* [n/a]; Terlingua Ranch, Red Bluff Hill, *JFS 820* [n/a], *821* [98]; just NW of Cedar Springs Rd. and Marathon Rd. jct., *JF 2421* [n/a], *2428* [n/a]. Big Bend National Park: Maverick Rd, 0.8 mi N of southern terminus, *JF 2356* [0, n/a]; Rt. 11 mi. 6.7, *JF 2334a* [5]*, *2334c* [n/a], *2334e* [n/a, n/a, n/a, n/a, n/a]; Rt. 11, mi 17, *JF 2335a* [n/a], *2335b* [24], *2353b* [n/a, n/a, n/a, 47]; Old Ore Rd., Roy's Peak jct., *JF 697* [83]; *698* [53]; *699* [n/a] *700* [n/a], *2340* [n/a], *2340a* [n/a, n/a], *2341a* [n/a, n/a, n/a], *2341b* [n/a, n/a, n/a, n/a, n/a].

Corynopuntia densispina × C. grahamii

USA. TEXAS. **Brewster Co.** Big Bend National Park: Old Ore Rd., N of La Noria, *JF 2391* [n/a]; Old Ore Rd., SW of Ernst Tinaja jct., *JF 2355* [93].

Corynopuntia grahamii × C. schottii

USA. TEXAS. **Terrell Co.** North of Dryden, *JF s.n.* [n/a].

Appendix E. Character comparison of the *Corynopuntia schottii* complex in the Big Bend region. Unless otherwise noted, measurements given in cm. Descriptions, especially spine characters, refer to the most mature or developed structures of the plant.

	C. aggeria	*C. densispina*	*C. emoryi*	*C. grahamii*	*C. schottii*
Chromosome number (*n*)	11	22	22	22	33
Plant habit	Tight mound	Open mound	Clumps / mound / mat	Small clumps	Small clumps to vast mats
Root habit	Tuberous	Diffuse, thickened	Diffuse, hair-like	Tuberous	Diffuse, hair-like
Adventitious roots common	No	Yes	Yes	No	Yes
Plant width	30 – 60	30 – 150	30 – 150+	15 – 30	15 – 300+
Plant height	15 – 30	10 – 30	10 – 30+	10 – 20	5 – 12
Joint attachment	Strong	Strong	Strong	Weak	Weak
Joint growth origin	Lateral	Lateral	Lateral	Apical	Lateral
Joint length	3.5 – 8	6 – 9	9 – 15	2 – 5	2 – 8
Joint size ratio	2-3x long as broad	2-3x long as broad	≥ 3x long as broad	1-2x long as broad	≥ 3x long as broad
Joint shape	Clavate, elongated	Clavate, elongated	Clavate, elongated	Obovate to cylindric	Clavate, J-shaped
Tubercle shape, abaxial profile	Rounded/ inflated	Rounded/ inflated	Rounded/ inflated	Rounded/ inflated	Flat/ deflated
Areolar wool habit; where most abundant	Protruding, villous; basally	Protruding, villous; basally	Flat/short, felt-like; apically	Protruding, villous; basally	Flat/short, felt-like; apically
Central spine no.	1 – 4 (6 – 9)	(4) 7 – 11 (+)	6 – 8	7 – 8	6 – 8 (10+)
Central spine shape: adaxial/ abaxial	Flat / angled	Flat / angled	Flattened but no angles, oval profile	Terete (rare: slight angle below)	Flat / angled; thinned margins

Appendix E, continued. Character comparison of the *Corynopuntia schottii* complex in the Big Bend region. Unless otherwise noted, measurements given in cm. Descriptions, especially spine characters, refer to the most mature or developed structures of the plant.

	C. aggeria	*C. densispina*	*C. emoryi*	*C. grahamii*	*C. schottii*
Central spine color; tone	Various, with white/gray; streaked	Yellowish (pinkish), white/gray; streaked	Tan/golden brown; saturated	Peach to red-brown; saturated, blotchy	Tan to red-brown, white margins; saturated, blotchy
Central spine base shape / color	Bulbous / differently colored	Flared to bulbous / diff. colored	Flared (uppers flared to bulbous)	Bulbous / diff. colored, iridescent	Undifferen-tiated, hidden by wool
Central spine epidermis	Smooth, farinose, especially distally	Smooth, farinose, especially distally	Variously ridged, thin appressed trichomes	Lateral ridges, robust appressed trichomes	Smooth, longitudinal striations
Main central spine present	No	No	Yes	No	No
Central spines often twisted	Yes	Yes	No	No	No
Subcentrals present	No	No	Yes	No	Yes
Diminutive subcentral	No	No	No	No	Yes
Location of most mature spine clusters in joint	Upper half to third	Upper half	Upper half	≥ Upper $^{3}/_{4}$	Upper half
Radial spine color	Bright white; bases different	Bright white/gray; bases various	Light tan	White; bases different, iridescent	Cream-tan
Radial spine number (pairs)	1 – 2 (3)	2 – 3	2 (3)	3 – 4 (5+)	2 – 3
Radial spine aspect (esp. lowest pair)	Appressed and decurved at base	Appressed and decurved at base	Descending	Appressed to decurved at base	Descending

Appendix E, continued. Character comparison of the *Corynopuntia schottii* complex in the Big Bend region. Unless otherwise noted, measurements given in cm. Descriptions, especially spine characters, refer to the most mature or developed structures of the plant.

	C. aggeria	*C. densispina*	*C. emoryi*	*C. grahamii*	*C. schottii*
Long 1° radial pair	No	Yes	No	Various	No
Glochids in brachyblasts	Common	Common	Rare	Common	Rare
Glochid/areole habit towards base of plant	Often increased, radiating, protruding	Often increased, radiating, protruding	No pattern	Often increased, radiating, protruding	No pattern
Location of joints with flower buds	Terminal	Terminal	Terminal	Terminal	Medial
Conic leaf length, pericarpel rim areoles (mm)	< 5	< 5	≤ 5	< 5	> 5
Bud proliferation common	No	No	No	No	Yes
Flower color	Yellow	Yellow	Yellow	Yellow (pink)	Yellow
Filament color	Red, pink	Green, red, pink	Green/clear	Green/clear	Green/clear
Stigma lobe color	Green	Green	Cream	Green	Green
Fruit color, at maturity	Green	Green	Yellow	Green	Yellow
Phenology	(Feb-)Mar–Apr(-May)	(Mar-)Apr–May	May–June	(Mar-)Apr–May	(May-)Jun(-Jul)
Woody old growth	Yes	Yes	Yes	Yes	No

Appendix F. Specimens used to populate range dot map, additional to those already referenced in this report. Specimens were either reviewed via the SEINet portal online, annotated as a loan, or via photo request (MO, US). Underlined collection numbers indicate the specimen is also a chromosome number voucher. See Methods and Materials for abbreviation explanations.

Corynopuntia aggeria

MEXICO. CHIHUAHUA. 25 km NE of Escalon, *MAB 15667* (ASC).

MEXICO. COAHUILA. SE of Torreón, *MAB 12819* (ASC); Bolsón de Mapimí *DJK K-8126* ASC); 16.8 mi N of Aldama *EL L22846* (ASC); 10 km WSW of Cuatro Cienegas *MAB 12817* (ASU, DES).

USA. TEXAS. **Presidio Co.** N of Ruidosa, *BER 130*. **Brewster Co.** Terlingua, *WW 476*; Big Bend National Park, N of Talley Mtn, *MSA 83* (MICH); S of Chilicotal Mtn, *MSA 21* (MICH); Dagger Flat, *AMP 5223*; Old Ore Rd., *AMP 6078*; River Rd, *BER 126.*

Corynopuntia emoryi

USA. TEXAS. **Presidio Co.** Porvenir, *BHW 47473*; near Candelaria, *BER 113, SL 3.*

Corynopuntia grahamii

MEXICO. CHIHUAHUA. 5 km NW of La Cruz and Rio Conchos, *MAB 15662* (ASC); 54 mi S of Chihuahua City on Rt 45, *DJP P-13374* (ASC); Ciudad Juarez, *RDW 11680* (ASC); 2 km W of Juarez, *RS 11798* (UTEP).

MEXICO. COAHUILA. N of Ocampo, *MAB 15672* (ASC); 106 km E of Torreón, *DJP P-13875* (ASC); Cuatro Cienegas Basin, *DJP 5279* (ASC).

MEXICO. DURANGO. 20 mi S Leon Guzman Plaza, Rt. 40, *DJP P-13458* (ASC); ca. 19 air mi W Torreón, *DJP P-13866* (ASC); 21 air mi SW Torreón, *DJP P-13864* (ASC).

USA. NEW MEXICO. **Doña Ana Co**. Franklin Mtns, *Champie 3934* (UNM); Bishop's Cap Mtn., *GW 3422* (UNM). **Otero Co.** Brokeoff Mtns, *GW 3829* (UNM).

USA. TEXAS. **El Paso Co.** El Paso, *AZ 2631* (DES), *RDW 32137* (UTEP); Franklin Mtns, *Ferguson 149* (UTEP); Hueco Mtns, *RDW 19354* (DES, UTEP). **Jeff Davis Co.** 96 Ranch on the Rio Grande, *PRM s.n.* **Hudspeth Co.** Indian Hot Springs, *GGR 89*-49. **Presidio Co.** N of Ruidosa, *MSA 1074* (MICH); Solitario, *JEH 702* (SRSC)*; RDW 23061* (UTEP). **Brewster Co.** Nine Point Mesa, *PRM 988* (SRSC), *MSA 909* (MICH); Terlingua, *PRM 960,* BBNP, River Rd, *BER 121,* BBNP, Lone Mtn, *MSA 827* (MICH), BBNP, Chilicotal Mtn *MSA 21* (MICH); FM 2627 near La Linda, *BER 119*; Reagan Canyon, *BHW 47449* (SRSC), *MSA 977, 1005* (MICH).

Corynopuntia schottii

MEXICO. COAHUILA. Cuatro Cienegas Basin, *Lewis ASU59091, DJP P-5539, DJP 5714, DJP 4123-A* (*ASC*).

USA. TEXAS. **Brewster Co.** Reagan Canyon, *MSA 981* (MICH). **Pecos Co.** FM 2400, *BER 104.* **Terrell Co.** FM 2400, *BER 109*; E of Langtry, *Trelease DES54522* (DES); Hwy 90 at Pecos River bridge, *AMP 6244.* **Val Verde Co.** N of Dryden, *SL 30*; near Comstock, *BER 101, DW 40* (UNM); Lake Amistad, *AMP 3436.* **Schleicher Co.** W of Eldorado, *JFW 1103.* **Brown Co.** Brownwood, *Palmer 11121* (MO). **Webb Co.** W of Laredo, *DW W478* (UNM), near Laredo, *DW 221* (UNM). **Zapata Co.** 5 mi. E of Zapata, *LV 2782* (UNM). **Starr Co.** W of Rio Grande City, *TP s.n.* **Hildalgo Co.** Near Reynosa, *EUC 1884* (MICH). **Cameron Co.** Brownsville, *Runyon s.n.* (US!).

Corynopuntia aggeria × C. grahamii

USA. TEXAS. **Brewster Co.** Terlingua Ranch, *JFS 821*; BBNP, Dagger Flat Rd. *AMP 5223;* BBNP, SE of Castolon, *MSA 11* (MICH).

Appendix G. Comments on, and corrected erratum for, previously published photographs of *Corynopuntia schottii* complex species.

Anderson 2001

p. 347. Identified as *C. schottii* however the red filaments, tightly bunched habit, and long white-containing central spines indicate *C. aggeria*.

Anthony 1956

p. 241, Fig. 10. Identified as *C. schottii*, however based on the locality and tightly mounded habit the photo shows *C. aggeria*. Fig. 12 is correct as identified. Fig. 13 shows *C. aggeria*.

Benson 1982

p. 369, Fig. 367. Identified as *C. schottii*, though considering the tightly bunched habit, flat white/light-colored central spines, and apparently darker-colored filaments, as well as reported locality of Tornillo Creek, Big Bend National Park, this photo shows *C. aggeria*.

p. 370, Fig. 368. The drawing of *C. schottii* includes some typical characters such as lateral growth, clavate joints, thin pericarp with longer conic leaves, flattened central spine, and what could be construed as diminutive central spines, though the spine cluster depiction is not exactly representative. The fleshy mature fruit (Fig. 368, 4) is atypical, normally being more swollen-spindle-shaped, tubercles not apparent, with stellate glochids from protruding areoles.

p. 371, Fig. 369. Rather than showing only characters representative of *C. grahamii* as identified, this drawing represents characters known in *C. schottii* (diminutive central spines, fruit) as well as *C. aggeria* (tuberous roots; lateral stem growth; elongate-clavate stems; long, decurved central spines; few central spines; basally-abundant glochids,), and *C. grahamii* (tuberous roots; apical stem growth; small, ovate stem shape (Fig. 369, 2); rounded tubercles; numerous radial spines; basally-abundant glochids). Drawing taken from original species publication in Engelmann (1859).

Evans 1998

p. 58: Identified as *C. grahamii*, however the tightly packed stems, white-grey flat spines, and pink-red filaments indicate *C. aggeria*.

p. 70: Identified as *C. schottii*, however the tightly mounded stems, spines decurved and white, plus numerous buds and flowers indicate *C. aggeria*.

Hunt et al. 2006

p. 479, 479.1: *C. aggeria* correct as identified, clearly showing red filaments, sparse spines, and bunched habit. 479.4: *C. emoryi* correct as identified, with its relatively short centrals and robust stems; this plant was in cultivation in Alpine, TX, resulting in the discordant background of volcanic rocks and fallen oak leaves. 479.5: Identified as *C. emoryi* however the apical stem growth, terete central spines, and abundant glochids, are traits associated with *C. grahamii*. 479.6: *C. grahamii* correct as identified.

p. 481, 481.3: Identified as *C. schottii* however the red filaments, purple-white central spines with iridescent bulbous bases, and bunched habit indicate *C. aggeria*. 481.4: Identified as *C. schottii* however it is likely an *C. aggeria* morphotype due to the red filaments, white central spines, and abundant glochids

Konings 2009

p. 164: Background photo is of *C. schottii*, as identified, showing its typical matted habit in south Texas. Pictures 2 and 3 (upper and lower right corners) are likely of a hybrid between *C. grahamii* (prominent wool in the globose new stem growth, some terete and pink/brown central

spines) and *C. aggeria* (lateral stem growth, some flat white central spines, abundant buds, pink filaments, fertile fruits).

p. 165: *C. grahamii* correct as identified, by its apical stem growth, numerous terete central spines, isolated mounded habit as opposed to extensive, matted growth.

Powell and Weedin 2004, Powell, et al. 2008

Plate 34, 35: *C. schottii* correct as identified, especially regarding the yellow ripening fruit, but perhaps introgressed with *C. grahamii* as it is lacking broad tan-brown central spines with white margins, and obviously clavate, J-shaped stems.

Plate 36: *C. grahamii* correct as identified, especially regarding the apically-chaining stems at top center of photo; however flowers appear to have darker, perhaps pink-red filaments which would indicate a degree of introgression with *C. aggeria*. Plants are in cultivation thus the atypical habitat of volcanic rocks and fallen oak leaves.

Weniger 1988

p. 318: Likely *C. grahamii* as identified, however atypical with elongate cylindric joints, white and tan-red central spines, and tightly associated stems. Not pictured in natural habitat.

p. 320: *C. schottii* correct as identified with the typical clavate stems, broad and brown central spines with white margins, and yellow ripening fruits. Not pictured in natural habitat.

p. 321: *C. emoryi* (*C. stanlyi*) correct as identified.

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A NEW PROGRESSIVE POLYCHROME PROTOCOL FOR STAINING BRYOPHYTES

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ABSTRACT

A general staining protocol for bryophytes is described, with exemplars of species of the family Pottiaceae (Bryophyta). The protocol assesses the color reaction to dilute potassium hydroxide, then to the addition of a mixture of dilute toluidine blue O and dilute ruthenium red. Colors are distinctive in various portions of plant anatomy. In addition to the preliminary KOH reactions of taxonomically important yellow or red anatomical structures, particularly reactive to TBO and RR are collenchyma in the distal laminal cells (green), laminal papillae (blue or pink), and leaf awns, axillary hairs, tomentum and paraphyses (deep pink). Mounting in glycerol further clarifies the distinctions between anatomical features. It is hypothesized that pectic mucilage is present in several plant organs, including tomentum and leaf awns, and may be important in water conservation.

Aqueous or vital staining of bryophytes for histochemical and taxonomic study has a long history in bryology, recently reviewed by Glime and Wagner (2013), including chromosome staining, histology, and clarification of pore type in sphagna. Additional discussion of the histochemical use of stains is recently reviewed by Konrat et al. (1999). Major works on aqueous stains for plants and animals in general include those of Gatenby and Beams (1950), Preece (1972), Ruzin (1999), and Yeung et al. (2015).

Potassium hydroxide

A 2% solution of potassium hydroxide (KOH) has been used in bryology, particularly in the study of the moss family Pottiaceae (Zander 1993: 3), for many years. It commonly demonstrates a yellow or red reaction in the distal lamina and other plant parts, these color reaction usually specific to genera. The colors last a fairly long time in glycerol mounts.

Toluidine blue O

Certain dyes are alone metachromatic (as discussed at length by Keating (2014), and these express different colors depending on the tissue stained. Toluidine blue O, a basic (acidophilic) thiazine dye, is one of these (see O'Brien et al. 1964; others are cresyl violet acetate, methyl violet and pseudoisocyanin). According to Keating (p. 88) staining with toluidine blue O (TBO) will express:

(1) pinkish purple with carboxylated polysaccharides (e.g. pectic acids);
(2) purplish or greenish blue with macromolecules with free phosphate groups (e.g. nucleic acids);
(3) green, greenish or bright blue with polyphenolics (lignin, tannins, while xylem walls are blue-green and phloem fibers bright blue);
(4) unstained are hydroxylated polysaccharides like starch and cellulose; and
(5) pinkish purple with polyuronides such as primary walls of epidermis or parenchyma.

Parker (1982) gave a shortened version: green or blue-green for xylem and sclerenchyma; red for phloem, red-purple for collenchyma and parenchyma.

TBO provides a pinkish purple color with carboxylated polysaccharides such as pectic acid; green, greenish blue or bright blue with polyphenolic substances such as lignin and tannins; and purplish or greenish blue with nucleic acids. Staining is more intense at low pHs (2.5–3.5) (Preece 1972: 266).

Collenchyma contains only primary cell wall tissue and is characterized by its uneven walls. It is, with sclerenchyma, a support tissue, but collenchyma provides a flexible support because it stretches. Angular collenchyma is common in moss leaves, most strongly expressed as cell wall trigones.

Ruthenium red

Ruthenium red is generally considered a specific stain for pectin mucilage but Luft (2005) found it only semispecific for pectin. The dye binds to polysaccharides that are highly substituted with acidic residues such as carboxyl groupings (Yamada 1970), for instance polyanions like pectic rhamnogalacturonans. Gums and mucilages are also stained, doubtless because they are composed in part with pectin (Engelbrecht et al. 2014). It is much used in histochemistry and electron microscopy (Fallel & Edmiston 2009). As the metachromatic TBO reacts to pectic substances with a pink-purple color that is different but not particularly distinctive, adding RR to the stain makes pectic-laced anatomical structures clearly stand out as bright pink or at least deep red-purple against TBO-stained green or blue non-pectic cells.

A progressive polychrome protocol

This staining schedule is termed "progressive" in that dilute KOH is the first test reagent. Adding RR and TBO changes the color responses to a significant extent. The greatest change is that bryophyte tissue of primary walls included collenchyma reacting yellow in KOH will respond green in TBO, particularly cell walls thickened with collenchyma. Thus, one notes the color in KOH, which is taxonomically significant, before adding TBO and RR for a final stain.

There are other polychrome stains, such as polychrome methylene blue, a mixture of methylene green, methylene azure, methylene violet, and methylene blue (Focosi 2015), or astra blue and basic fuchsin (Kraus et al. 1998), or safranin and alclan blue (Tolivia & Tolivia 2011), or even a combination of several dyes (Shellhorn & Hull 1961). These are generally used in medicine, not for bryophytes. The present protocol, as far as I can tell, has not been used previously on any organism.

METHODS

The images were captured with an Olympus CX41 microscope mounting a Moticam 2000 2.0 MP resolution camera, Motic Images Plus software (Motic China Group 2004) and Moticam Multi-focus software. They were cropped and slightly sharpened and color-balanced with Neopaint (Neosoft 2010) graphics software.

The mounting medium is Zander's (2014) polyvinyl alcohol-glycerol solution (PVOH-G). This is a mixture of polyvinyl alcohol-based clear glue (sold commercially by Elmer's and Colorations) and glycerol in a 7:3 proportion (emended from the 1:1 proportion of the 2014 article which has proved to solidify too slowly or sometimes not at all). This is essentially a glycerol mount stabilized by the polymer. Perhaps because the water-based glue greatly dilutes the glycerol, there is little osmotic effect that might shrivel the plant cells. The index of refraction in glycerol favors clarity of observation of small anatomical features over viewing in water mounts.

The staining reagents and dyes used for the progressive polychrome staining protocol (PPSP) are 2% solution of potassium hydroxide (KOH), 0.2% ruthenium red (RR) stain solution, and 0.2% toluidine blue O (TBO) stain solution.

TBO usually comes from the sales source in a 1% solution, which is far too concentrated as it quickly overstains and precipitates small, solid particles of TBO. Dilute to about 1:5 to 1:10, and continue diluting until the stain is just adequate (makes an olive leaf color) for the group you are working on. The same is true with RR, and a perfectly adequate solution is made by placing a fingernail-sized bit of the power in the bottom of a dropper bottle, and fill with water until you can just read print through the glass of the bulb-tipped dropper. Or simply follow the instructions by Glime and Wagner (2013: 2–2–18). Both TBO and RR are enhanced by buffering but this is not advised as KOH is a crucial ingredient in the protocol.

The protocol

1. Wet plant or plant portion in 2% KOH solution on a microscope slide. Detach leaves, make sections, and other dissections when necessary.
2. Daub off excess KOH solution by tilting the slide against absorbent tissue.
3. Add one or two drops of dilute RR solution, immediately add the same amount of dilute TBO solution. Put the RR on first as TBO has a tendency to shrivel leaves. Stir.
4. If the plant material does not turn weak olive color after a short wait, then heat gently with a butane lighter (carefully so as to warm whole slide or it will break) or better on a warm hot plate like a coffee warmer. The solution will deepen in color and the tissue should get darker, a deep green.
5. Daub off the excess.
6. Add three or four drops of glycerol or polyvinyl alcohol-glycerol. The toluidine blue O will regain a blue color in solution, and the glycerol may gain a blue cast. Stir, arrange, add cover slip.
8. One can examine the slide immediately. For best color development leave overnight or use mild heat. A small fan or mild heat also helps solidify the mount. Under-staining of the leaf cells may be due to over dilution of the TBO, in which case, daub off the RR before adding TBO. Over-staining can be reversed by addition of a tiny amount of KOH, but this may clear the stain completely.

One might mount a bit of the plant in KOH + PVOH on the left, and in the PPSP on the right to show the original plant with its reaction to KOH for comparison purposes. The turquoise stain may be more green than in color, but should not be mistaken for chlorophyllose tissue because it stains the leaf completely, including otherwise clear cells, also stains older leaves in which chlorophyll has degraded, and close study shows the interior cell walls green.

TBO plus KOH stains leaf cell walls green but tomentum has hyaline walls with only cell contents bluish. RR stains the tomentum (and hyaline leaf awns) pink. Leaving the RR or TBO for a longer time on the tissues will deepen each stain. After adding both RR and TBO, wait until the leaves turn from a yellow color in KOH to a weak olive; if red in KOH, wait until there is a color change, usually brownish. The RR pink may be hidden by the TBO blue if the latter is left on too long or is too concentrated. Either stain may over-stain the tissues, in which case, dilute the solution in the dropper bottle and try again with new plant material. Strong heat (to boiling) changes TBO from blue to green, and will help develop the turquoise color if the tissues seem resistant.

RESULTS

The color reactions

The resultant yellow, red, blue, and green colors on the slides are not all permanent. Pink and blue fade over a few days, but yellow and green are quite fast in the PVOH-glycerol mountant.

Green: in plants with KOH yellow-staining leaves, collenchyma; angular cells walls, trigones, porose cell walls (Figs. 1 and 4). May take some time (up to a few hours) to develop as a deep bluish green (Fig. 10).

Red-brown to orange: red brown for stain-resistant yellow-brown cell walls (Fig. 3), or becoming orange or blue for cell walls of originally KOH-red staining tissues (chlorophyllose cell contents remain green but walls are orange).

Blue: cellulose, antheridia (Fig. 6), thin cell walls, cancellinae, some papillae (Figs. 10 and 11).

Blue-violet: cellulose; parenchyma.

Pink, violet or red: gums, mucilage, pectin; rhizoids (Fig. 9) and paraphyses (Fig. 6), some papillae (Fig. 12).

Yellow to brown: stain resistant; structural tissues, some wall thickenings that are not angular.

Papillae of laminal cells are often stained blue-violet or sometimes pink against the background of green-stained cell walls. This differential staining is valuable in that discerning the type of papillae is a major taxonomic exercise. Papillae morphology is occasionally difficult to describe because papillae are often very small, reduced, of one or more salients, or massively thickened into a somewhat amorphic mass ("flower-shaped papillae"), or sometimes hollow and appearing C- or O-shaped in optical cross section.

Perigonial buds (Fig. 6) are quite responsive to this staining procedure with unburst antheridia light blue (probably from a concentration of nucleic acids) and paraphyses pink or even deep red.

Details of technique and problems

Instead of daubing off excess KOH, RR and TBO, use just a small amount of KOH, then add the RR, then the TBO over that, wait for a color change or heat moderately, then drop the PVOH-G mountant into the middle of the preparation, and move the leaves and other material into the clear mountant, then add a cover slip and daub off stain surrounding the cover slip. The mountant will cleanse the extra stain from the plant material as the material is swished through it.

Adding a drop of vinegar (5% acetic acid) to the KOH with create a lighter, more bluish stain with TBO (becoming blue-green with time), and not affect the RR; however, there is then less difference between the green collenchymatous tissue and blue-staining leaf marginal cells and laminal papillae. Also, adding vinegar to neutralize the KOH removes the KOH-stained structural tissue reaction, such as the spaced streaks of brownish cells in linear rows running up the basal cells of certain *Leptodontium* species.

RR premixed with KOH throws a precipitate, and becomes deep red, but may be used although RR in water is best. TBO premixed with KOH precipitates fully and should not be used. RR and TBO react with each other. Thus water solutions of dilute RR and TBO in separate individual bottles is best.

Images of stained examples in the moss family Pottiaceae

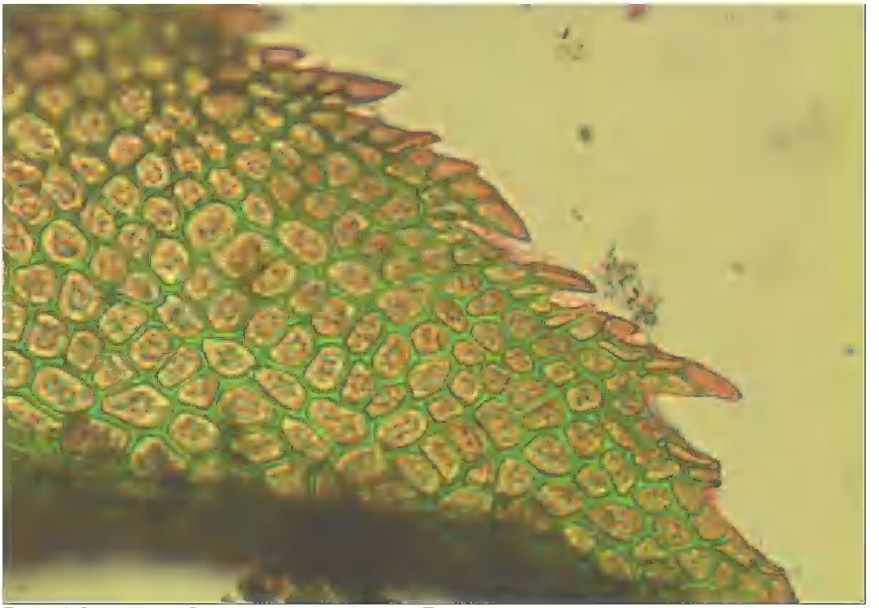

Figure 1. Leaf apex of *Leptodontium viticulosoides*. The collenchymatous internal cell walls are bright green, and the marginal teeth are reddish, indicating thinner cell walls.

Figure 2. Margin of leaf of *Vinealobryum vineale*. Again the internal cell walls are green, while the cell contents are green from chlorophyll. Without the stain, the cell walls are reddish in this species.

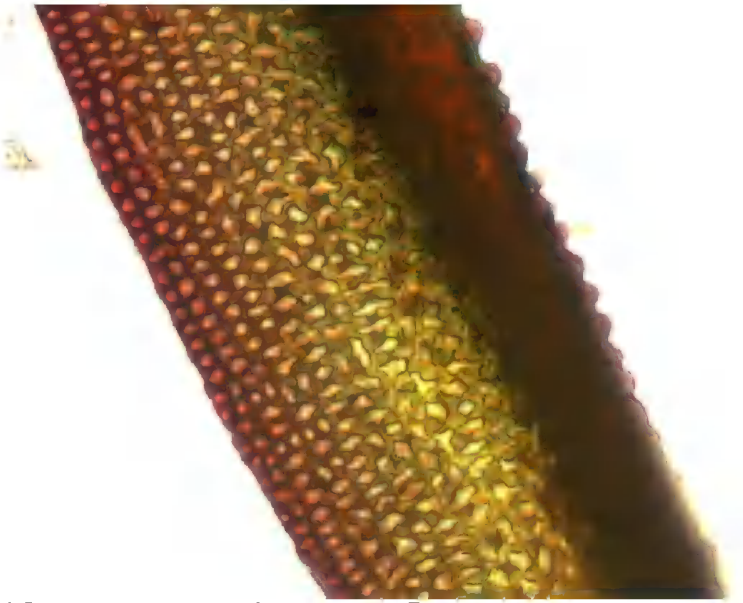

Figure 3. Portion of the upper leaf of *Geheebia gigantea.* The thick angular collenchyma is in the form of bulging trigones, which are yellow to greenish yellow, retaining the KOH reaction. The reddish brown coloration of the unstained or KOH soaked plants is typically somewhat unreactive, in this and other resistant species, to the TBO and RR.

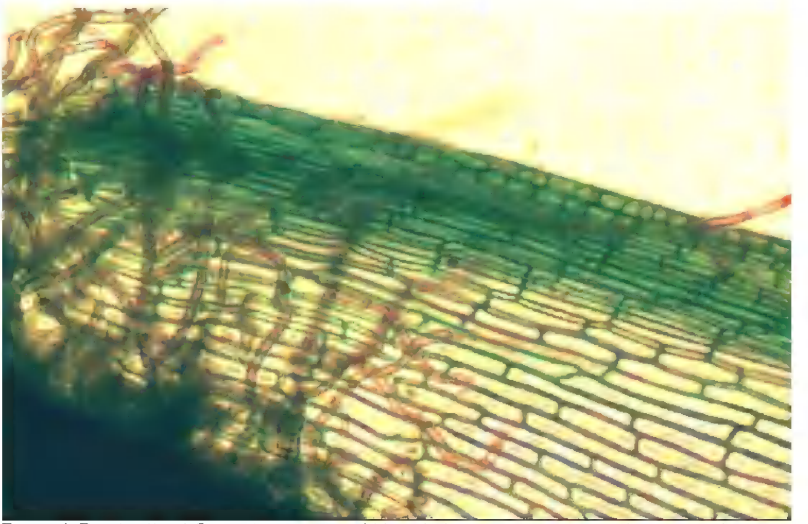

Figure 4. Basal cells of *Syntrichia princeps.* Although this species is russet red in nature, the protocol results in deep green marginal cells and green enlarged mid basal cells. The rhizoids are pink.

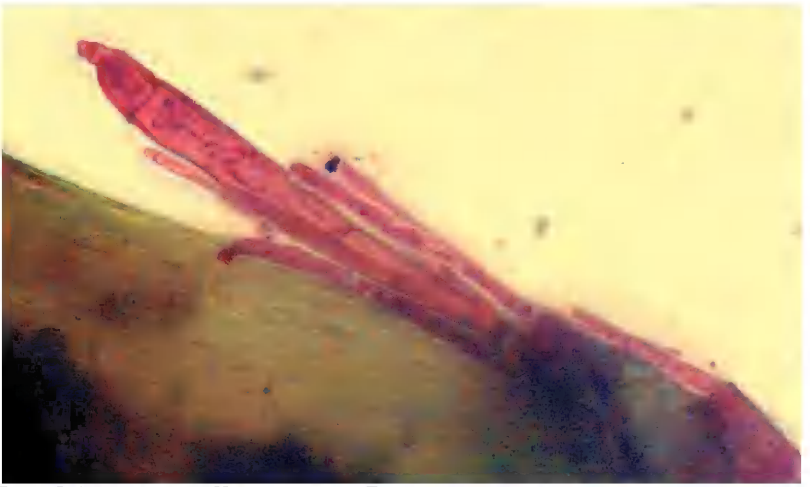

Figure 5. Axillary hairs of *Hyophila involuta.* The larger structure is probably the immature basal stalk of angular gemmae often produced in this species. Both hairs and gemmae stalks stain strongly for pectic mucilage.

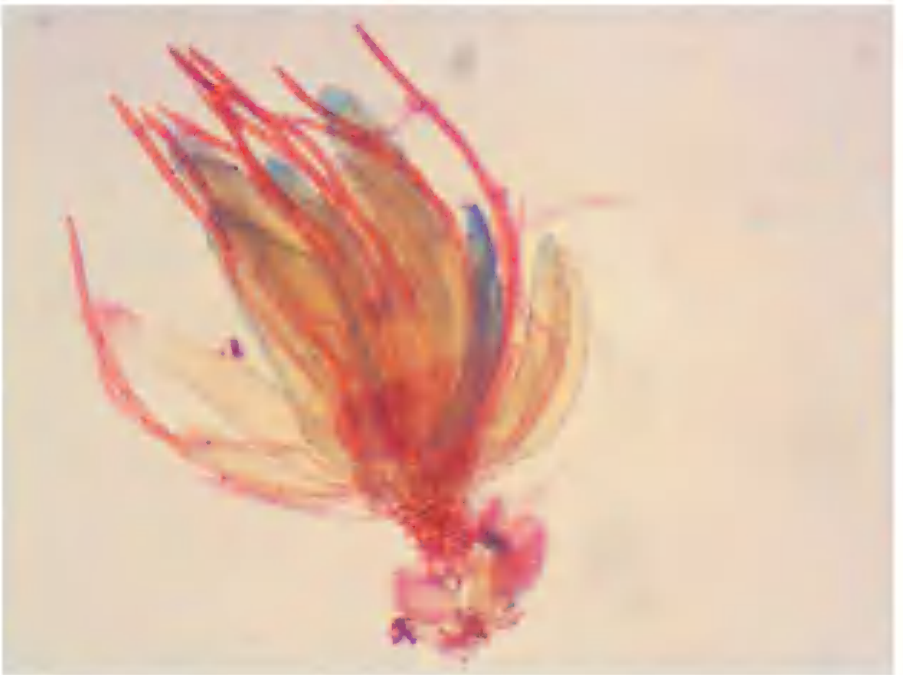

Figure 6. Androecium of *Trachyodontium zanderi.* The paraphyses stain a deep pink while the unburst antheridia are blue.

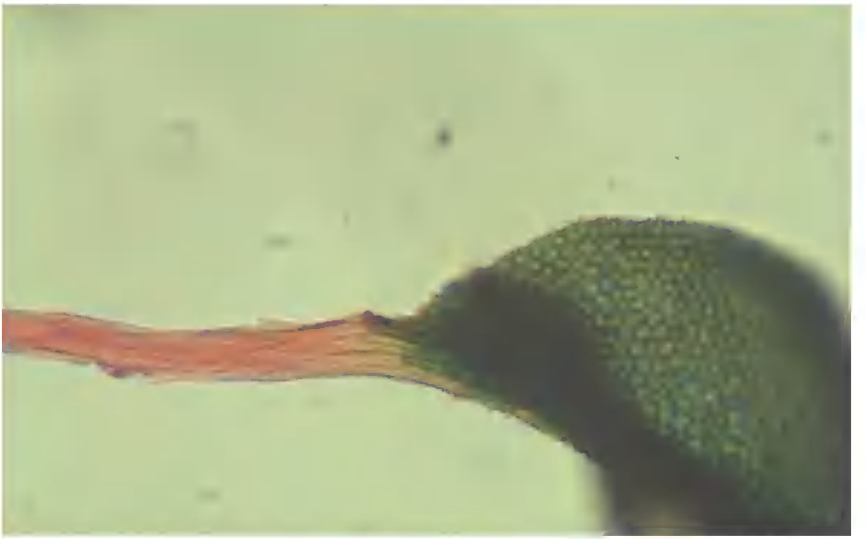

Figure 7. Apex of *Syntrichia princeps*. The leaf awn stains pink against the deep green of the distal lamina.

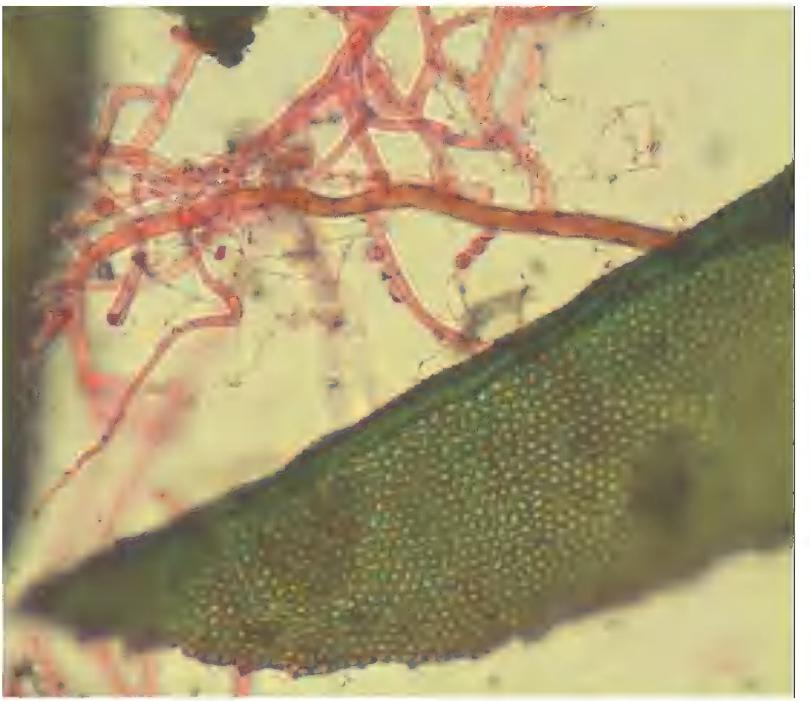

Figure 8. Tomentum and leaf tip of *Leptodontium viticulosoides*.

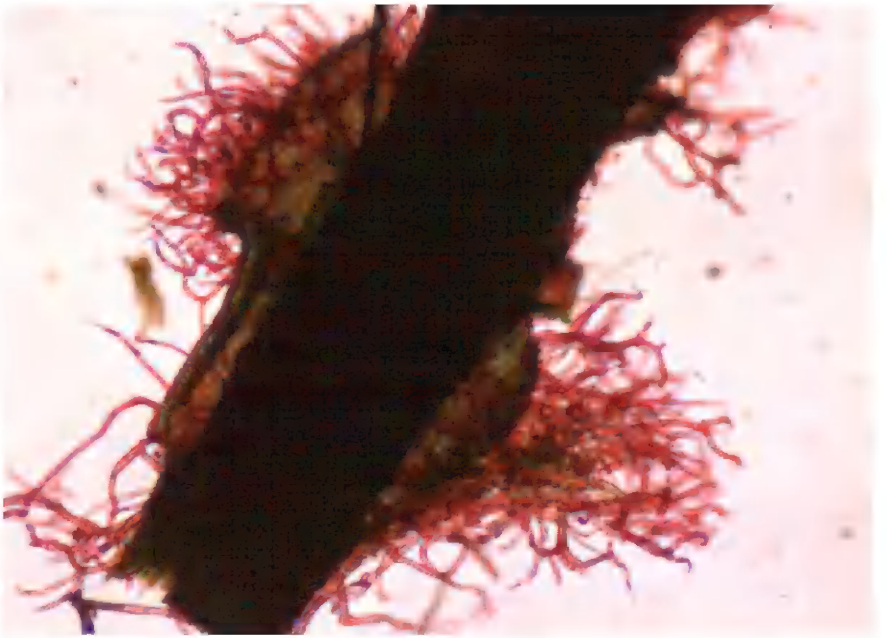

Figure 9. Tomentum of *Leptodontium tricolor.* The pink stain implies the present of pectic mucilage, which may be involved in water conservation.

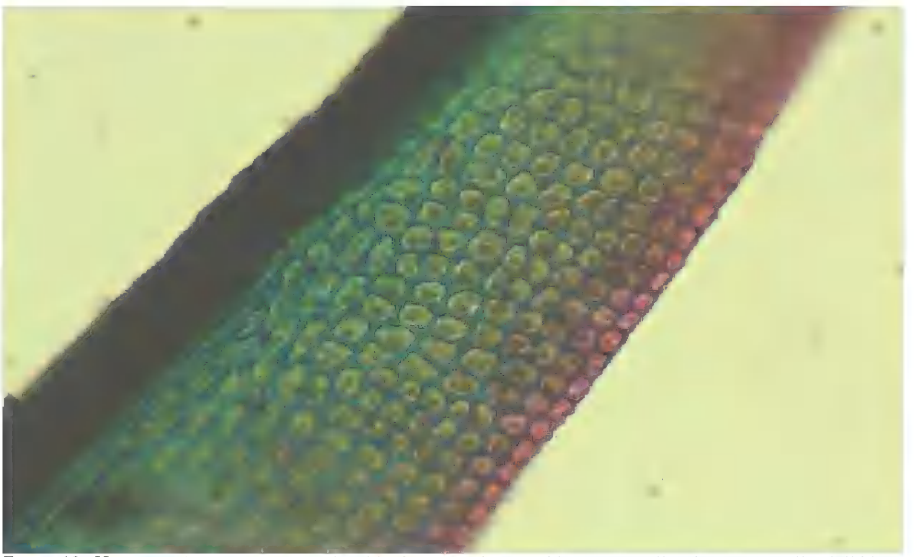

Figure 10. *Hymenostylium aurantiacum* distal leaf portion showing blue-green collenchymatous cells, dull blue large, simple papillae, and pink marginal cells that have thin cell walls.

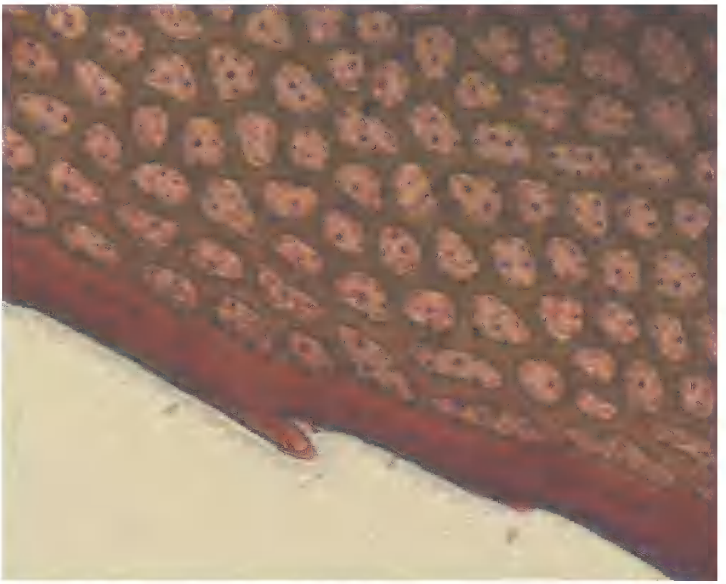

Figure 11. *Trachyodonium zanderi* showing blue, scattered, small, simple papillae over pink cell lumens and green(ish) collenchymatous internal cell walls.

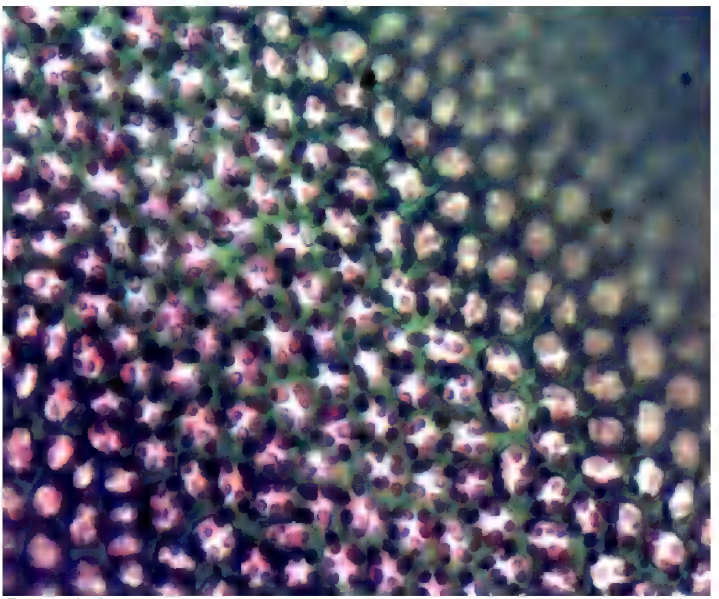

Figure 12. *Leptodontium viticulosoides* showing blue or violet bifid papillae and green collenchymatous internal cell walls.

DISCUSSION

The progressive polychrome stain protocol was revealing or at least potentially valuable in three ways. (1) Plant parts of intergrading morphology may be clearly distinguished on a chemical basis (e.g., laminal papillae morphology). (2) Both axillary hairs and perigonial paraphyses are apparently both essentially "mucilage hairs" and may have a lubricant function. Because tomentum and leaf costal awns also stain pink, a further selective function is possible, perhaps these last two act as water sponges. The habitat of tomentose or awned species is commonly arid or misty mountainous areas, often with tree bark substrates. (3) There are taxonomic differences in color reaction to TBO and RR in addition to that of KOH, but it is somewhat too early to declare these as indicators for chemical taxonomy. This is certainly so as multiple tests are necessary to ensure identification of cell constituents, as these stains are not perfectly selective.

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REINSTATEMENT OF *DIODIA HARPERI* (RUBIACEAE), A SOUTHEASTERN USA COASTAL PLAIN ENDEMIC

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ABSTRACT

Diodia harperi Small is reinstated as a species distinct from *D. virginiana*. From the latter it differs in several morphological characters, most notably its shorter and narrower capsules, shorter corolla tubes, and shorter leaves. *Diodia harperi* also differs from other, older, named taxa related to *D. virginiana*. Type material and all specimens examined are cited.

In the original description of *Diodia harperi* Small (1933), Small indicated that it differed from *D. hirsuta* Pursh, *D. tetragona* Walter, and *D. virginiana* L. by its short corolla tube (<5 mm vs. >6 mm), its globular capsule (vs. ellipsoid or ovoid), and by its eciliate sepals (vs. ciliate). Its habitat and range were given as "pond margins, Coastal Plain, s Ga."

Subsequently, most Georgia authors have not recognized *Diodia harperi* (Thorne 1954; Faircloth 1971; Lane 1976; Jones & Coile 1988; Drew, Kirkman, & Gholson 1998), although Duncan and Kartesz (1981) did accept it. Harper (1906) called attention to it as "*D.* sp. (near *D. Virginiana*, but probably undescribed). Berrien [County]. Margin of shallow pine-barren pond near Tifton, Sept. 26, 1902 (#1682)." The specimen cited by Harper (*Small 1682*) became the type of *D. harperi*.

Several morphological characters are significant in distinguishing *Diodia harperi* from the more common and widespread *D. virginiana* (Table 1). When ultimately deciding on species status, I placed primary emphasis on reproductive characters (fruit size and shape, corolla tube length) and secondary emphasis on leaf morphology (leaf shape and dimensions). Note that while *D. harperi* tends towards glabrous fruits and *D. virginiana* tends towards hirsute fruits, both species can span the range.

Table 1. Comparison of morphological characters between *Diodia harperi* and *D. virginiana*. Except where noted, measurements are based on 25 specimens (n = 25) from southeastern USA herbaria.

	D. harperi	*D. virginiana*
Leaf length at midstem	15-36 mm; mean 24.1 mm	(27-) 30-65 mm; mean 43.8 mm
Leaf width at midstem	3.5-10 mm; mean 6.2 mm	5-16 mm; mean 8.9 mm
# of leaf pairs per 10 cm of midstem	(3-) 4-8 pairs; mean 5.5 pairs	3-5 pairs; mean 4.0 pairs
Corolla tube length	4.0-7.5 mm; n=10	6.5-10.0 mm; n=11
Capsule length	(4.0) 4.5-6.0 (-6.5) mm; mean 5.0 mm	6.5-8.0 (-9.0) mm; mean 7.3 mm
Capsule shape	rotund to broadly ellipsoid	narrowly ellipsoid to broadly ellipsoid

Capsule pubescence	glabrous (n=11);
	sparsely hirsute (n=6);
	moderately hirsute (n=1);
	densely hirsute (n=1)
		sparsely hirsute (n=4);
		moderately hirsute (n=7);
		densely hirsute (n=10)

Diodia harperi and *D. virginiana* share a large geographic range and likely occur syntopically, given the broad ecological tolerance of both species. However, none of the specimen labels that I examined, those that were originally determined as *D. harperi, D. tetragona,* or *D. hirsuta*, stated that the plant co-occurred with *D. virginiana.* The small number of equivocally identified specimens (see citations, Appendix 2) indicate that the *D. harperi* and *D. virginiana* are reproductively isolated and are justifiably considered as good biological species.

The three taxa cited by Small as differing from *Diodia harperi* are addressed here. I consider all three to be synonyms of *D. virginiana.*

1. *Diodia tetragona* Walter. Due to its longer corolla tube, Small (1933) recognized *D. tetragona* as distinct from *D. harperi.* However, Small noted that the fruit of *D. tetragona* was the same size (4.5–5.5 mm) and shape (Small says "ovate" for *D. tetragona*, but I describe it as broadly elliptical) as that of *D. harperi* ("about 5 mm"). My research shows that corolla tube length of *D. harperi* and *D. tetragona* are confluent. However, fruit size differs significantly: 4.5–6.0 mm in *D. harperi* vs. 6.5–7.5 mm in *D. tetragona.* Moreover, fruit shape differs: rotund to broadly ellipsoid in *D. harperi* vs. ellipsoid to narrowly ellipsoid in *D. tetragona.* I examined online the type specimen of *D. tetragona* at MPU (*Fraser s.n.,* 1788); the fruits measure 7.0 mm and are narrowly to broadly elliptical. Therefore, I conclude that *D. tetragona* Walter is synonymous with *D. virginiana* L. Note #1: Ward (2008) did not include *D. tetragona* in his list of Walter types; he was probably unaware of the specimen at MPU, which was annotated in 2012 by Paul Fabre (Herbier Universite Montpellier 2015). Note #2: The length of fruits –– 7.0 mm — in the type of *D. tetragona* is at odds with the 4.5-5.5 mm as stated by Small (1933). It is highly doubtful that he examined *Fraser s.n.* or other type material and instead Small may have had in front of him specimens that I would place within *D. harperi.*

2. *Diodia hirsuta* Pursh was recognized by Small at species rank but as a variety by Torrey and Gray (1841) [*D. virginiana L.* var. *hirsuta* (Pursh) Torrey & A. Gray] and as a forma by Fernald (1950) [*D. virginiana L.* forma *hirsuta* (Pursh) Fern.]. After examining hundreds of sheets of *Diodia virginiana*, I agree with Fernald that the entity *hirsuta* is merely a morphological form of *D. virginiana* that appears at scattered points nearly throughout its range. In such plants, leaves and stems are variously hirsute, but otherwise there are no discernible differences in flower or fruit size from normal *D. virginiana.* Similarly hirsute plants occur sporadically throughout the range of *D. harperi*, as noted in the species description in this paper.

3. *Diodia virginiana* L. var. *latifolia* Torrey & Gray. According to the authors (1841), var. *latifolia* has ovate-lanceolate leaves and ovate fruits. Torrey and Gray synonymized *D. tetragona* Walter here. They noted, however, that "We find so many intermediate forms between *D. virginica* [sic], *tetragona,* and *hirsuta* of authors, that we can scarcely distinguish them even as varieties." Var. *latifolia* is considered here to be a populational variant of *D. virginiana.*

KEY TO NORTH AMERICAN *DIODIA*

1. Capsule length 6.5–9.0 mm, narrowly ellipsoid to broadly ellipsoid; corolla tube length 6.5–10.0 mm; leaf length at midstem 30–65 mm ..... **Diodia virginiana**
1. Capsule length 4.0–6.0 (–6.5) mm, rotund to broadly ellipsoid; corolla tube length 4.0–7.5 mm; leaf length at midstem 15–36 mm ..... **Diodia harperi**

Diodia harperi Small, Man. S.E. Fl. 1264. 1933. **TYPE**: **USA**. **Georgia**. [Tift Co.]: Protologue: "Pond margins, Coastal Plain, S. Ga." Label: Berrien Co.: Margin of shallow cypress pond S of Tifton, 350 ft, 26 Sep 1902, *R.M. Harper 1682* (holotype: NY!, Fig. 2; isotype: NCU!).

Small (1933) cited type specimens for new species and new combinations, beginning on page 1503. *Diodia harperi*, however, does not appear on this list, apparently an inadvertent omission. The city of Tifton and surrounding portions of Berrien County were transferred into the newly created Tift County in 1905.

Perennial creeping herbs with multiple branches that are prostrate to ascending and up to 20 cm long (occasionally longer), glabrous to moderately hirsute. Leaves opposite, relatively crowded (4–8 pairs per 10 cm of midstem vs. 3–5 pairs in *D. virginiana*), elliptical to narrowly lanceolate, 15–36 mm long and 3.5–10 mm wide at midstem (vs. 30–65 mm long and 6–16 mm wide in *D. virginiana*). Flowers axillary, sepals 2, corolla salverform, white to pale lavender, the tube 4.0–7.5 mm (vs. 6.5–10.0 mm). Fruit a capsule, glabrous to hirsute, broadly ellipsoid to rotund (vs. narrowly ellipsoid to broadly ellipsoid), 4.5–6.0 mm long (vs. 6.5–8.0 mm), black to dark brown, ribbed. Variation in leaf morphology is illustrated in Figure 1.

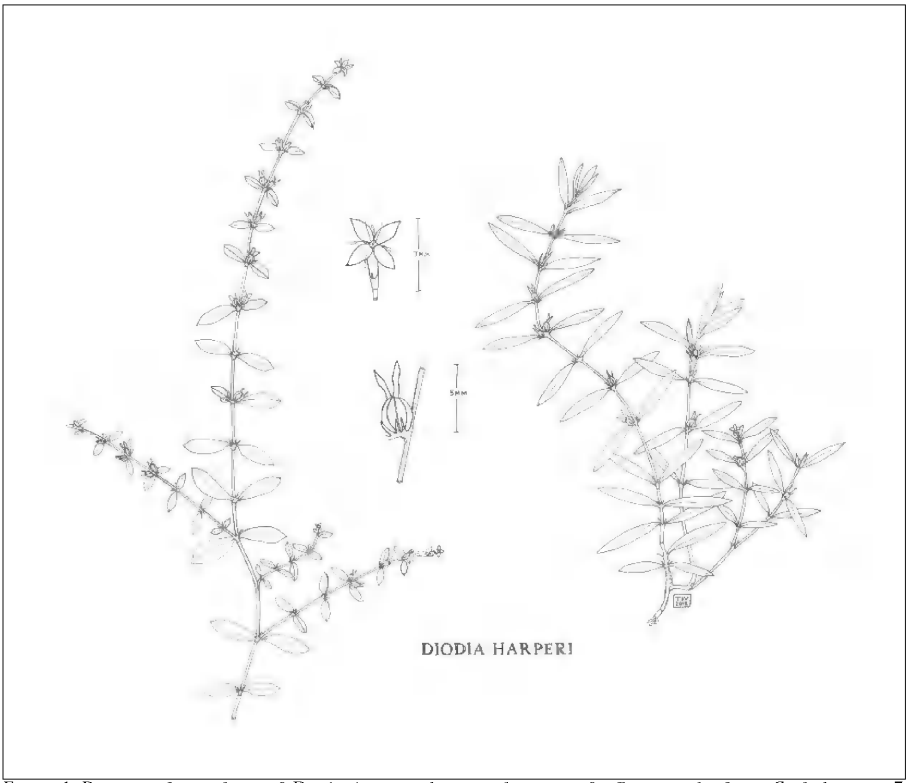

Figure 1. Portions of two plants of *Diodia harperi*, showing close-ups of a flower and a fruit. Scale bars are 7 mm long (flower) and 5 mm long (fruit). Drawing by Tori Wahlstrom.

Figure 2. Holotype of *Diodia harperi* Small (*Harper 1682*, NY).

Distribution. *Diodia harperi* ranges from eastern North Carolina to southwest Florida and west to southeastern Texas, southeastern Oklahoma, and central Arkansas (Figure 2). It is virtually endemic to the Coastal Plain Floristic Province. It is widespread within this range and no doubt occurs in other counties and parishes. Several specimens from the Ouachita Mountain region of Arkansas were all collected from low elevations — less than 500 feet — and likely represent local incursions from the adjacent coastal plain or from the Arkansas Valley. The range of *D. virginiana* extends from Connecticut, Illinois, and Kansas south to southern Florida and southeastern Texas.

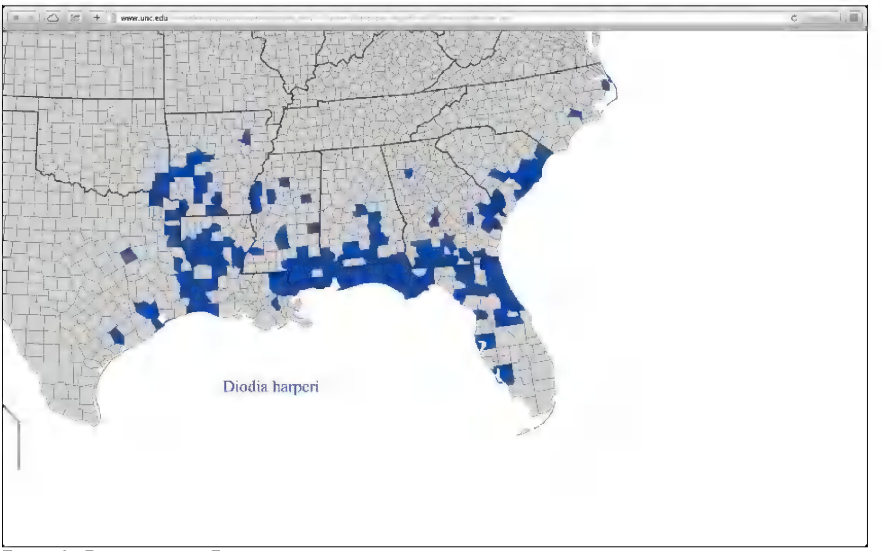

Figure 3. Distribution of *Diodia harperi*.

Habitat. *Diodia harperi* occurs in natural depression ponds, cypress-gum ponds, pitcher plant seepage bogs, moist to wet pine flatwoods, shores of blackwater streams, shores of brownwater rivers, interdune swales, roadside ditches, borrow ponds, and various disturbed areas. These habitats center on permanently moist to wet acidic soils, open sun to light shade, and little competition. This relatively broad range of habitat types supports a correspondingly broad range of associated species. The specimen label for **Crenshaw County, Alabama** (*Hansen & Goertzen 1,644*), lists the following associates at a wet streamside: *Hedyotis* sp., *Lobelia cardinalis*, *Sagittaria latifolia*, *Onoclea sensibilis*, *Sida rhombifolia*, and *Glandularia pulchella*. The specimen label for **Covington County, Alabama** (*Sorrie & Stowell 8,602*), lists the following associated species at a wet pine savanna: *Muhlenbergia expansa*, *Aristida beyrichiana*, *Schizachyrium tenerum*, *Rhynchospora plumosa*, *Xyris caroliniana*, *Ludwigia hirtella*, *Ludwigia virgata*, *Rhexia alifanus*, *Pycnanthemum nudum*, *Agalinis obtusifolia*, and *Chaptalia tomentosa*. Another wet savanna in **Hancock Co., Mississippi**, supported members of *Sarracenia*, *Drosera*, *Dichromena*, and *Xyris* (*Jones & Jones 12,637*). The specimen label for **Suwannee County, Florida** (*Abbott 22,179*), lists the following at a blackwater river bank: *Betula nigra*, *Diospyros virginiana*, *Nyssa biflora*, *Taxodium distichum*, *Sebastiania fruticosa*, *Cyrilla racemiflora*, *Cyperus spp.*, *Clematis crispa*, *Trachelospermum difforme*, *Hedyotis procumbens*, and *Pentodon pentandrus*. The specimen label for **Calhoun County, Georgia** (*Carter 19,309*), lists the following at a flatwoods pond margin: *Taxodium ascendens*, *Nyssa biflora*, *Quercus laurifolia*, *Lyonia lucida*, *Cephalanthus occidentalis*, *Clethra alnifolia*, *Hypericum spp.*, and *Woodwardia virginica*. The specimen label for **Baker County, Georgia** (*Gholson & Jackson 11,702*), lists the following at a

depression pond: *Axonopus furcatus*, *Euthamia tenuifolia*, *Helianthus angustifolius*, *Panicum hians*, *Croton elliottii*, and "typical form of *Diodia virginiana*." The specimen label for **Bryan County, Georgia** (*Zebryk 0438*), lists the following at a pine flatwoods: *Pinus palustris*, *Xyris caroliniana, X. brevifolia*, *Linum floridanum*, *Rhexia alifanus, Rhexia mariana*, *Lycopodiella alopecuroides*, and *Lachnanthes caroliniana*. The specimen label for **Galveston County, Texas** (*Rosen & Winzer 5,296*), lists the following from a wet flat on a barrier island: *Spartina patens*, *Leptochloa nealleyi*, *Cynanchum angustifolium*, *Mimosa strigillosa*, and *Schoenoplectus pungens*.

Phenology. *Diodia harperi* has been documented in flower from 16 May to 25 August (sporadically to 11 October) and in fruit from 27 May to 22 November.

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Appendix 1. *Diodia harperi* collections examined (275 total).

Alabama. Baldwin Co.: 3 mi N of Foley, open ground along railroad, 21 Oct 1950, *Whitehouse 24,285* (BRIT); damp situation of otherwise dry pine land about Elberta, 25 Aug 1925, *Wolf 2,392* (AUA); recently cleared pineland bog by Ala. 112, 21.5 mi SE of Bay Minette, 18 Aug 1968, *Kral 32,551* (BRIT). **Chilton Co.** [**Baker Co.** as written on label; Baker was renamed in 1874]: damp soil and cultivated grounds, Aug 1873, *Smith s.n.* (UNA). **Conecuh Co.:** locally common around farm pond on county road 42, 0.9 mi W of Covington county line, 3 Oct 1981, *Lynch 43* (UNA); on county road 42 at Covington County line, ca. 5 mi SE of Brooklyn, common in wet ditch, 8 Aug 1979, *Davenport 1511* (UNA). **Covington Co.:** longleaf pine sandhills and bog by US 331, 3 mi N of Florala, 26 Jul 1968, *Kral 32,085* (AUA, BRIT); ca. 2 mi W of Wing on county road 4, sandy pineland, 18 Sep 1971, *Kral 44,293* (BRIT); sandy peat of swale in site-prepped hills by county road 20, just E of county road 4, 26 Jul 1990, *Kral 78,108* (BRIT); S side of county road 4, 3.0

mi E of Ala. 54, moist pine savanna with scattered longleaf and slash pines, frequent in wet portions, 13 Sep 1995, *Sorrie & Stowell 8,602* (NCU); Solon Dixon Forestry Education Center, swampy pond along main entrance road, dominated by *Nyssa*, 20 Jun 2008, *Hansen & Goertzen 3,339* (AUA); unnumbered dirt road 0.3 mi N of county road 82, dry sandy cutover pine woods, 17 Sep 2005, *Diamond 15,779* (BRIT). **Crenshaw Co.:** dirt road between East Fork Bradley Branch and Indian Creek, wet sandy pine woods, 13 Aug 2005, *Diamond 15,646* (AUA, BRIT); along highway 10 ca. 1 mi W of Rutledge at Patsaliga Creek, wet sandy soil, 9 Sep 2004, *Hansen & Goertzen 1,644* (AUA); county highway 59 ca. 0.3 mi N of Dry Creek, moist sandy roadside, 13 Aug 2004, *Diamond 14,606* (AUA, BRIT). **Elmore Co.:** low sandy pasture by AL 9, 5 mi N of Wetumpka, 31 Aug 1969, *Kral 36,626* (BRIT, GA). **Geneva Co.:** borrow pits along dirt road from Pea River to Liberty Chapel, 25 Aug 1966, *Clark 7697* (NCU); savanna, sandy peat, by county 4, ca. 10 mi E of Florala, 2 Aug 1971, *Kral 43,450* (BRIT, GA); longleaf pine sandhils, W side of Geneva, sphagnous bog, 25 Jul 1968, *Kral 32,021* (AUA, BRIT, UNA); sand and peat of shore of drying pond, S side Ala. 52, 8 mi NE of Geneva, 10 Sep 2000, *Kral 90,259* (BRIT). **Houston Co.:** nearly dry depression pond just NE of Indigo Pond, 11 Sep 1995, *Sorrie & Stowell 8,579* (NCU); Dothan southside along St. Andrews Bay railroad, 6 Sep 1992, *MacDonald 5,395* (BRIT). **Lee Co.:** Auburn University Dairy Research Unit Lake, 7 mi N of Auburn, 13 Aug 1969, *Ellis 173* (BRIT). **Mobile Co.:** roadside of N-S road to Bellingrath Gardens, ca. 1 mi N of junction with AL 188, 23 Jun 1966, *Clark 3,584* (NCU); 11 1/2 mi S of Mobile, sandy ditch flat pine land, 29 Jul 1950, *Shinners 12,752* (BRIT); Dauphin Island, roadside near pine forest and dunes, 26 Jun 1964, *Deramus D143* (BRIT); Dauphin Island, ca. 1 mi SE of Bienville Square, common behind first low dune from Gulf, 8 Oct 1967, *McDaniel 9,930* (BRIT, GA); Dauphin Island, E end, 17 Oct 1973, *Taylor & Taylor 15,218* (BRIT, NLU); Dauphin Island, freshwater swamp in Audubon Bird Sanctuary, 25 May 1973, *Taylor & Taylor 13,350* (BRIT, NLU); spoilage in swampy bottom, Chickasaw Creek, N of Mobile on US 43, 20 Aug 1968, *Kral 32,698* and *32,699* (BRIT, GA); Alabama Port, pine savannah, 23 Aug 1951, *Chermock s.n.* (UNA). **Monroe Co.:** 0.6 mi E of county road 59 from state rte. 41, edges of stream and roadside, 1 Jul 1972, *Hybart 105* (AUA); sandy peaty edge of gum bay by U.S. 84, 5.3 mi E of jct. Ala. 21, 18 Jul 1995, *Kral 85,350* (BRIT). **Montgomery Co.:** by loop bypass just N of U.S. 80, WSW side of Montgomery, disturbed low area, 10 Oct 1970, *Kral 41,592* (BRIT). **Pike Co.:** dirt parking lot of Troy State University Arboretum, sandy disturbed soil, 28 Jun 1988, *Diamond 5,098* (AUA). **Washington Co.:** on U.S. 43 at Clarke Co. line (Tombigbee River), ca. 3 mi NE of Leroy, common at edge of backwater, 6 Aug 1979, *Davenport 1,448* (UNA); county road 3, ca. 7 mi W of Millray, abundant in wet mud of road ditch, 5 Aug 1980, *Haynes 8,096* (UNA); 4.3 mi N of Citronelle, moist bank along railroad through pine-turkey oak, 5 Sep 1965, *Kral 25,984* (AUA, BRIT); 5 mi S of Chatom, sandy peat of pineland bog, 14 Jul 1969, *Kral 35,534* (BRIT); longleaf pineland bog 3.1 mi S of St. Stevens, 21 Sep 1969, *Kral 37,217* (BRIT); alluvium of Tombigbee River bottoms where crossed by U.S. 43 S of Jackson, 14 Jul 1969, *Kral 35,591* (BRIT).

Arkansas. Calhoun Co.: edge of woods beside Locust Bayou, S of rte. 4, 12 Sep 1993, *Thomas 137,423* (NLU). **Clark Co.:** Amity, clearing 150 yards E of railroad, soil wet from seepage, 7 Aug 1985, *Brooks & Kuhn 17,600* (NLU); gravel bars of Caddo River, P.O. Amity, 25 Oct 1969, *Demaree 61,364* (BRIT). **Hot Spring Co.:** low wet areas, P.O. Malvern, 10 Oct 1953, *Demaree 34,479* (BRIT). **Jackson Co.:** beside rte. 18 at Village Creek, 8 Jul 1968, *Thomas 10,252* (NLU). **Miller Co.:** moist banks of Red River at bridge to Fulton, 14 Oct 1963, *Demaree 49,130* (BRIT). **Montgomery Co.:** moist bottom, very common, P.O. Mount Ida, 11 Oct 1952, *Demaree 33,144* (BRIT, MISS); gravel bars of Caddo River, 7 Oct 1958, *Demaree 40,609* (BRIT). **Nevada Co.:** bottoms of Little Missouri River, 19 Jun 1963, *Demaree 48,154* (BRIT). **Perry Co.:** above mud flats to high water line, Nimrod reservoir, 15 Jul 1949, *Wolff s.n.* (BRIT); banks of cold stream below Nimrod Dam, 31 Aug 1958, *Demaree 40,374* (BRIT). **Polk Co.:** Mena, along railroad between 8th and 9th Street, 4 Oct 1992, *Thomas & Thomas 131,986* (NLU). **Union Co.:** Just N of Junction City, Cornie Creek bottoms, 29 Oct 1964, *Kral 23,257* (BRIT); along railroad E of rte. 129 in Huttig, 1 Sep 1989, *Thomas 112,410* (NLU); same place 11 Oct 1987, *Thomas 102,616* (NLU); bottomland

hardwood forest along W bank of Ouachita River, 0.5 mi N of Louisiana line, 26 Sep 1991, *Thomas et al. 125,353* (NLU). **Yell Co.:** low wet areas above Nimrod Lake, 17 Sep 1970, *Demaree 62,874* (BRIT).

Florida. Alachua Co.: peaty bottom of dried up pond, 3 mi SE of Hawthorne, 25 Jul 1961, *Godfrey & Reinert 61,097b* (BRIT, FSU); O'Leno State Park, Pareners Branch Loop Trail through mesic woods, 12 Aug 1989, *Tan 41* (NLU). **Bay Co.**: shallow water of roadside ditch, NW side of North Bay, 13 Jun 1957, *Williams s.n.* (FSU); low area in clay pineland, 3 mi SE of Youngstown, 12 Aug 1954, *Ford 4589* (FLAS). **Calhoun Co.:** bordering route 73, 0.5 mi S of Clarksville, frequent in dry sand of cutover pine woods, 18 Oct 1982, *Anderson 6257* (FSU). **Charlotte Co.:** Webb Wildlife Area, pine-palmetto flatwoods with *Panicum tenerum* and *Pluchea foetida*, 22 Nov 1963, *Lewis 117* (GA). **Citrus Co.:** near Hernando, wet margin of Lake Tsala Apopka, 2 May 1961, *Cooley et al. 8,225* (BRIT). **Clay Co.:** swampy pasture land mile S of Penney Farms. 7 Sep 1945, *Totten s.n.* (NCU). **Columbia Co.:** O'Leno State Park, along Wire Road in path, 1 Sep 1989, *Amoroso & Tan 28* (FSU). **Dixie Co:** flatwoods, 1.5 mi S of Steinhatchee River on FL 19, 21 Aug 1937, *no name s.n.* (FLAS). **Duval Co.:** low rich places near Jacksonville, Jul (no year), *Curtiss 1115* (GA, MISSA, USF); moist pine barrens near Jacksonville, 5 Oct 1894, *Curtiss 5035* (GA); same place, 29 Aug 1898, *Curtiss 6219* (FLAS, NCU). **Escambia Co.:** sandy open field in Pensacola, 21 Jun 1941, *Brinker 41* (FSU). **Flagler Co.:** flatwoods, 5 mi E of county line, near FL 28, Andalusia, 10 Oct 1940, *West & Arnold s.n.* (FLAS); Bunnell, sandy edge of pond off rte. 1, 3 mi S of town, 8 May 1969, *Churchill s.n.* (BRIT); 2.5 mi ESE of Bunnell, moist sandy peat of palmetto flatwoods bog, 10 Aug 1963, *Kral 18,538* (BRIT). **Franklin Co.:** in shallow water forming extensive thick mats, margin of cypress-gum pond, 7 mi N of East Point, 24 Jul 1957, *Godfrey 55725a* (NCU); frequent with *D. teres* in moist sandy loam in wooded floodplain of Apalachicola River at Bloody Bluff Landing, 4 Sep 1985, *Anderson 8730* (FSU); Tates Hell Swamp, just NW of first road going W of Tucker Road along Double Bridge Road, 24 Aug 1995, *Lindholm s.n.* (GA); open clearing on U.S. 98, 6.4 mi E of Gulf County line, 7 Jun 1971, *Browne & Browne 71G9.2* (NLU). **Gilchrist Co.:** Suwannee River Water Management District, 47 Bridge Tract, degraded bottomland forest, 6 Sep 2005, *Abbott 20594* (FLAS). **Gulf Co.:** Cape San Blas, ca. 6 mi NW of lighthouse, open white sandy area in slash pine-sand pine-myrtle oak, 21 Jul 1967, *McDaniel 9,501* (BRIT). **Hamilton Co.:** scattered plants in bare sand, bank of Suwannee River, 5 mi S of Georgia line, 8 Oct 1966, *D'Arcy 1,220* (FSU, GA); dry bank of Suwannee River, White Springs, 30 Sep 1941, *West & Arnold s.n.* (FLAS). **Hendry Co.:** Okaloochee Slough State Forest, 6.2 km E of route 29, marshy wet flatwoods, 3 Sep 2011, *Franck 2725* (USF). **Hillsborough Co.:** proposed Cone Ranch wellfield, edge of marsh, 25 Aug 1991, *Bailey 56* (FLAS). **Holmes Co.:** 4.1 mi W of Ponce de Leon, low swampy area surrounded by moist pine woods, 9 Jul 1964, *McDaniel 4,851* (FSU); disturbed land about Choctawhatchee River bridge, route 2, 21 Jul 1954, *Ford 3,494* (FLAS). **Jackson Co.:** moist pineland, 11 mi W of Chattahoochee, 9 Aug 1947, *Thorne 5,957* (GA); marshy shore of lake 1 mi E of Marianna, 27 Sep 1957, *Godfrey & Kral 5,925* (BRIT); Lake Seminole Wildlife Refuge, scattered plants amongst grasses and sedges in wet mucky areas along marshy shore, sometimes forming thick mats, 15 Oct 1958, *Monoson 33* (FSU); Apalachee Game Management Area, along Lake Seminole, 4 mi N of Sneads, 11 Sep 1982, *Knight 781* (FSU); moist sands of pond bottom, Race Pond, W of Lake Seminole, 1 Oct 1977, *Godfrey 76,046* (FSU). **Lake Co.:** 7 mi SW of Okahumpka, frequent on moist sandy peat of savanna, 5 Aug 1958, *Kral 7,620* (FSU). **Lee Co.:** North Fort Myers, sandy peat of clearing in slash pine-palmetto flats, 24 Jul 1963, *Kral 18,013* (BRIT). **Leon Co.:** abundant on bottom of dried-up pond, N side of Tram Road, SE of Tallahassee, 8 Jul 1976, *Leonard 6332* (FSU). **Nassau Co.:** pine flatwoods W along Quail Road, White Oak Plantation, 17 Aug 2000, *Rider 316* (FLAS). **Okaloosa Co.:** frequent amongst grasses and *Ludwigia* along N edge of Karick Lake, Blackwater State Forest, 11 Oct 1996, *Anderson 17,180* (BRIT, FSU, NCU, USCH); Fred Gannon Rocky Bayou State Recreation Area, frequent in sand bordering outlet to Puddin Head Lake, 20 Jun 1994, *Anderson 14985* (FSU); narrow swamp along Shoal River, S of Dorcas, 2 Aug 1954, *Ford 3923* (FLAS). **Orange Co.:** ca. 3 mi S of Oakland, frequent in moist sand of lakeshore, 7 Aug 1958, *Kral*

7,722 (GA); Moss Park, W shore of Lake Mary Jane, sandy open disturbed lake shore grading into *Typha* marsh, 25 Aug 1981, *Hansen & Lindsey 8,734* (USF); wet place S of Winter Garden, 6 March 1957, *Schallert 26,690* (BRIT). **Pinellas Co.:** Clearwater, edge of palmetto scrub, 6 May 1970, *Genelle & Fleming 227* (NLU); Braidentown, 7 Jul 1900, *Tracy 7,086* (BRIT). **Putnam Co.:** open fields and margins of mixed hardwood/pine forest next to hwy. 100, W of Palatka, 6 Jun 1998, *Slaughter 10,093* (NLU). **Santa Rosa Co.:** 16 mi N of Navarre, sparse slash pine savanna N of Yellow River, 9 Jul 1964, *McDaniel 4,891* (BRIT, FSU). **Sarasota Co.:** edge of scrubby flatwoods, Deer Creek Prairie Preserve, 29 Sep 2007, *Franck 383* (FLAS). **St. Johns Co.:** clearcut wet pine flatwoods/bayhead, Cowan Swamp, 12 Jul 2006, *Slaughter 14,919* (BRIT). **Suwannee Co.:** W of White Springs, sandy riverbank along Suwannee River, Blue Sink Tract, creeping plant, 14 Aug 2006, *Abbott 22179* (FLAS). **Volusia Co.:** Daytona Beach, Road 600 W of Halifax Hospital, flatwoods, 31 Aug 1947, *Hume s.n.* (GA). **Wakulla Co.:** moist sandy banks of roadside ditch just E of Panacea, 22 Jul 1957, *Godfrey 55,616* (FSU); 2.5 mi NW of Newport, pine flatwoods, 25 Jul 1964, *McDaniel 4,940* (BRIT); along sandy road between highways 365 and 367, N of Spring Creek, wet cut and bulldozed slash pine area, 27 Jul 1970, *Lazor 4,562* (FSU). **Walton Co.:** moist grassy road leading to junction of Alaqua Creek and Little Alaqua Creek, 20 Jun 1967, *Smith 1,526* (FLAS); wet place SE of jct. U.S. 331 and U.S. 98, ditch by road, 19 Oct 1973, *Sutherland 114* (AUA); sparse woods on N side U.S. 98, 10.9 mi SE of jct with U.S. 331, 20 Oct 1973, *Kratzer 00135* (UNA). **Washington Co.:** Falling Waters State Park, lower slope of seepage bog near sinkhole trailhead, 28 Sep 2000, *Carr 6671* (FLAS); abundant in mucky soil between railroad and U.S. 90, Caryville, 5 Aug 1960, *McArthur s.n.* (NLU). **no county named:** "Florida", no date, *Chapman s.n.* (NCU).

Georgia. Baker Co.: Ichauway Plantation, NW of Richardson Flat, small depression pond dry due to severe drought, plant with upright growth habit, 4 Aug 1986, *Gholson, Jr. & Jackson 11702* (GA). **Berrien Co.:** low wet pinelands and adjacent water-filled borrow pit along highway 64, 2 miles NNE of Ray City, 29 Jun 1965, *Faircloth 1950* (GA, NCU). **Brooks Co.:** low pineland, 3 miles NE of Pavo, 6 Jun 1955, *Adams 42* (GA); low wet alluvial area beneath highway bridge over Little River, 2.5 mi NNE of Barney, 1 Jul 1966, *Faircloth 3251* (GA, NCU); 2.5 mi W of Dixie Crossroads along U.S. 84, pine flatwoods, 27 Jul 1967, *Kral 28,696* (BRIT); sand terraces on W side of old highway 84, at abandoned Blue Springs resort area, 22 Oct 1976, *Dixon 74* (GA, NCU, NLU). **Bryan Co.:** Fort Stewart Military Reservation, Training Area B-17, mesic ditch adjacent to longleaf pine flatwoods, 7 Jul 1992, *Zebryk 0438* (GA). **Bulloch Co.:** 3 3/4 mi SE of Statesboro, sandy roadside, 19 Aug 1961, *Boole, Jr. 1,172* (BRIT). **Calhoun Co.:** Georgia 216, 0.3-0.5 mi S of Edison, sandy silty openings in oak-spruce pine flats, 6 Sep 2002, *Kral 93170* (BRIT); 6.63 air mi N of Leary, E side C.R. 136, extensive flat and pond margin with *Taxodium ascendens*, 6 Aug 2009, *Carter & Baker 19,309* (GA). **Charlton Co.:** 1.5 mi W of St. George on highway 94, low ditch, 11 Jul 1979, *Jones & Loew 23,348* (GA); Waycross State Forest, N of Big Creek, 1/2 mi below Walker Dam, open pine palmetto forest, 6 Aug 1960, *Kuns 32* (BRIT). **Clinch Co.:** disturbed low area along rte. 441, ca. 12 mi SE of Homerville, 18 Aug 1998, *McNeilus 98-783* (BRIT, NLU). **Cobb Co.:** along Rotten Wood Creek at bridge on North Expressway beside I-275, Atlanta, 30 Sep 2000, *Thomas 167,687* (NLU). **Colquitt Co.:** low open pitcher-plant bog alongside US 319, 9.7 mi NE of Moultrie, 10 Jun 1964, *Faircloth 1,129* (GA). **Decatur Co.:** shallow muddy pond 12 mi SW of West Bainbridge, 17 Jun 1947, *Thorne 4,738* (GA); sandy peaty slough along railroad 5 mi W of Whigham, 5 Jul 1964, *Kral 20,552* (BRIT). **Dooly Co.:** partially drained cypress pond, 2.7 mi SSE of Unadilla on W side of railroad, 31 Jul 1953, *Duncan, Harper, & Humphrey 16,837* (GA); longleaf pine-black gum flat 3 mi S of Pitts Junction, 22 Aug 1972, *Kral 48,139* (BRIT). **Dougherty Co.:** *Kral 91,728* (BRIT). **Echols Co.:** waste area around sand and borrow pits on SW side of Little River, 6.9 mi E of Lake Park, 16 Jul 1965, *Faircloth 2,312* (GA). **Effingham Co.:** flat damp pine barrens a little N of Eden, 2 Sep 1961, *Harper 4,486* (UNA). **Grady Co.:** wet open woods along head of Maxwell Creek, 6.5 miles S of Quitman, 27 Aug 1963, *Faircloth 537* (GA, NCU); sandy peat at edge of cypress by US 84, 3.5 mi E of Cairo, 3 Aug 2000, *Kral 90,238* (BRIT, GA); sandy peat of transition pine flatwoods to titi, Hadley Ferry Road, 8 Jun 2002, *Kral 92,706* (BRIT); seep area, powerline clearing through longleaf pine

hillside, E off of rte. 112 W of Cairo, 26 Aug 2002, *Kral 93,109* (BRIT). **Houston Co.:** mixed hardwoods between Scout Lake and Luna Lake, Robins Air Force Base, 16 Jun 1979, *Dixon 1436* (NLU). **Irwin Co.:** moist pine-cypress savanna, intersection of Irwin and Ben Hill Counties at US 129, 15 Jun 1962, *Plummer & Pullen s.n.* (GA); same place, 5 Jul 1962, *Plummer & Pullen s.n.* (GA). **Liberty Co.:** Fort Stewart Military Reservation, Training Area D-8, poorly drained flatwoods, common, 24 Jun 1992, *Carter & Lusk 9914* (GA). **Long Co.:** three year old pine stand in deep sand, 5 mi W on route 261 from US 301 at Beard's Creek, 6 Oct 1963, *Bozeman 1722* (GA); Griffin Ridge Wildlife Management Area, second entrance off 301S, abundant in flatwoods, 25 Jul 1999, *Holland & Luber 128* (GA). **Lowndes Co.:** 4.6 mi E of Valdosta on sandy peat of pine flatwoods, 13 Sep 1973, *Kral 51,660* (BRIT). **Mitchell Co.:** roadside ditch along edge of *Taxodium-Nyssa* pond, 2 mi E of Pelham. 24 Jul 1964, *Faircloth 1353-A* (NCU). **Screven Co.:** fine sandy soil at edge of bay, 9 mi E of Millen, 7 Aug 1942, *Duncan 5551* (GA). **Thomas Co.:** Thomasville, just E of jct. U.S. 319 and state rte. 35 in pinelandswale, sandy peat, 12 Jul 2004, *Kral 95,428* (BRIT). **Tift Co.:** drain of pine-barren pond near Tifton, 26 Sep 1902, *Harper 1682* (NCU, NY), [Note: the collection label says Berrien County, but part of Berrien was later excised to form Tift County]. **Toombs Co.:** moist pine barren, 3 mi E of railroad depot in Lyons, 19 May 1962, *Plummer & Pullen s.n.* (GA).

Louisiana. Allen Par.: roadside prairie between U.S. 165 and railroad, 1.8 mi S of U.S. 190, 24 Oct 1981, *Thomas & Allen 79,393* (NLU); cleared sandy area beside oil well in pine woods, S of U.S. 190, E of LeBlanc, 5 Aug 1983, *Thomas 84,698* (NLU). **Beauregard Par.:** along railroad and rte 27 between Juanita and Singer, flat pine land, 22 Aug 1971, *Thomas 24,630* (NLU); flat pine woods 5.9 mi SW of Singer on rte. 110, 5 Jun 1986, *Thomas , Allen, & Bordelon 96,660* (NLU). **Bienville Par.:** 11 mi SE of Minden, ditch, 26 Jul 1950, *Shinners 12,598* (BRIT). **Caldwell Par.:** 7.7 mi N of Riverton, damp clay bank above stream, 7 Oct 1955, *Shinners 21,842* (BRIT); behind levee in woods1 mi W of rte. 165 in Columbia, 23 Jun 1968, *Scarbrough 516* (NLU). **Calcasieu Par.:** pineland savannah-prairie, Starks, 22 Jul 1964, *Kral 20,969* (BRIT); cleared woods at gas well beside rte. 12 W of Starks, 5 Jun 1992, *Thomas 129,664* (NLU). **Cameron Par.:** field aslong Parish Road 104, 3.1 mi S of rte. 14, SE of Lake Arthur, 13 May 1984, *Thomas & Dutton 88,619* (NLU); roadsides and ditches along rte. 127, 3.7 mi S of Calcasieu Parish line, 3 Sep 1983, *Dutton & Taylor 187* (NLU). **Catahoula Par.:** waste area 0.3 mi W of headquarters of Delta Plantation, 21 Aug 1974, *Thomas & French 41,190* (NLU); disturbed area along W bank of Bayou Louis on S side of La. 8, 3 mi E of Harrisonburg, 21 Nov 1989, *Thomas 114,616* (NLU). **Concordia Par.:** 2 mi W of Ferriday, silty clay ditch bank, 30 Jul 1950, *Shinners 12,786* (BRIT); W bank of Mississippi River E of La. 15, 3.0 mi S of La. 131, NE of Deer Park, 7 Aug 1988, *Thomas 106,770* (NLU). **De Soto Par.:** pasture at proposed Cajun Electric's lignite powerplant site SE of Evelyn and La. 177, 28 Sep 1978, *Thomas & Dixon 61,169* (NLU). **Grant Par.:** Kisatchie National Forest, pastured open area beside experimental pine woods W of FS road 146, E of Bentley, 30 Jul 1981, *Thomas & Carroll 77,629* (NLU). **Lincoln Par.:** 4.5 mi E of Ruston on moist sandy clay of streambank, 4 Sep 1962, *Kral 15,724* (BRIT). **Natchitoches Par.:** Kisatchie National Forest, bog on Strange Road, N of La. 479 and W of Goldonna near Ragan Creek, 17 Oct 1986, *Thomas & Gilmore 98,857* (NLU); Kisatchie National Forest, "Fixit" pitcher plant bog, Bayou L'Ivrogne headwaters, 28 Jul 1989, *MacRoberts & MacRoberts 863* (BRIT); Kisatchie National Forest, "360B" grass-sedge hillside bog, 0.25 mi E of FR 360, 14 Jul 1990, *MacRoberts & MacRoberts 1059* (BRIT); Kisatchie National Forest, planted longleaf pine woods in flat area on SE side of FS road 605, S of Reidheimer, 26 Sep 2001, *Thomas et al. 171,929* (NLU). **Rapides Par.:** pine woods beside La. 112, 0.5 mi N of Allen Parish, 5 Nov 1978, *Thomas & Schutz 62,339* (NLU). **Red River Par.:** cut-over area in swampy woods near rte. 7, 4 mi N of Coushatta, 3 Oct 1967, *Thomas 5771* (NLU). **Sabine Par.:** Boise Southern holdings along Wolf Prong road W of rte. 118, 28 Jun 1980, *Carroll 1705* (NLU); along main road and within pitcher plant bog, Pearson Ridge WMA, 6 mi NE of Hornbeck, 31 Aug 1980, *Carroll 2003* (NLU). **St. Charles Par.:** common weedy species in damp sand alluvium, overflow of Bonnet Carre Spillway, 12 Oct 1947, *Ewan 17,437* (GA); same place, 27 May 1948, *Ewan 17,699* (GA). **St. Tammany Par.:** moist pineland, 1 mi N of Abita Springs, 14 Aug 1912, *Pennell 4153* (GA); Covington, Sulphur Spring, Aug 1919, *Arsene*

11,647 (BRIT); Covington, low sandy ground at Delta Primate Center, 12 Jul 1969, *Churchill s.n.* (BRIT). **Tangipahoa Par.:** longleaf pine woods 1/2 mi W of I-59, W of Fluker and S of La. 10, 25 Oct 1974, *Thomas 42,166* (BRIT, NLU); pine woods beside La. 40 and La. 445, W of Uneedus, 25 Sep 1975, *Thomas & Allen 46951* (NLU). **Washington Par.:** low wet areas, Franklinton, 26 Oct 1962, *Demaree 46,885* (BRIT); large clear cut area on hill S of route 436, 8 mi E of Pine, 15 June 1983, *Thomas 84,332* (UNA); Choctaw Trail NW of Sheridan, wetter soils of margins of pine-oak woodlands, small clearings, 19 Sep 1958, *Ewan 19,437* (BRIT). **Winn Par.:** 1.7 mi W of Winnfield, low ground along highway, 8 Jun 1955, *Shinners 20,283* (BRIT).

Mississippi. Bolivar Co.: Cleveland, campus of Delta State University, NW of football stadium in regularly mowed shallow drainage way, 7 Sep 2000, *Stewart 7074* (MISS). **Forrest Co.:** Ragland Hills, 21 May 1970, *Rogers 3296* (MISS); low area 5.1 mi SW of jct. highway 13 and U.S. Forest Service road 238, 22 Aug 1964, *Jones 2356* (MISS); 3.5 mi SW of Hattiesburg, longleaf pine land at clover leaf of highways 49 and 11, 28 Jul 1964, *Cooper 190* (MISS). **Greene Co.:** 2 mi WSW of Leakesville, highway 57, edge of low woods, 18 Jul 1966, *Jones & Hudson 8402* (MISS); acid bog 2 mi SE of Leakesville, highway 63, 18 Jul 1966, *Jones & Hudson 8456* (MISS); 3.1 mi N of jct. of Miss. 57 and 63, dry to moist clearcut, originally pine-oak, 25 Jul 1988, *McDaniel & Nace 30,123* (BRIT). **Hancock Co.:** ditches in wet flat pine woods, P.O. Bay Saint Louis, 24 Aug 1952, *Demaree 32,991* (BRIT, MISS, NCU); sandy fill along road on inland side of sea wall, in full sun, 1 mi SW of Clermont Harbor, 24 Jul 1969, *Jones 17,513* (MISS); acid savannah with *Sarracenia, Drosera, Dichromena,* and *Xyris*, 1 mi N of Necaise, 30 May 1967, *Jones & Jones 12,637* (MISS); flat coastal savannah, acid soil, full sun, Waveland at highway 90, 26 Aug 1966, *Jones & Jones 9,431* (MISS); Waveland at jct. Waveland Ave. and Beach Road, 31 Jul 1984, *Hermann 391* (NLU); 6.2 mi ENE of Pearl River, hwy. 90, sandy loam dry bog, 4 Jun 1961, *Lewis 5,695* (BRIT). **Harrison Co.:** river bottoms, P.O. Biloxi, 20 Aug 1952, *Demaree 32,951* (BRIT, NCU); Biloxi, 6 Sep 1898, *Tracy 4957* (MISS); low wet areas, P.O. Lyman, 6 Jul 1952, *Demaree 32,106* (BRIT, NCU); DeSoto National Forest, Rifle Range, open longleaf pine stand, common, 14 Aug 1964, *Johnson 432* (GA); moist sand near the coast, Henderson Point, P.O. Pass Christian, 28 Jul 1952, *Demaree 32,339* (BRIT); moist sand dunes of Bay Saint Louis, Henderson Point, P.O. Pass Christian, 12 Aug 1952, *Demaree 32,747* (BRIT, NCU); sandy peat of pine flatwoods boggy savanna, 5 Jul 1963, *Kral 17,553* (BRIT). **Jackson Co.:** Ocean Springs, 22 Aug 1891, *Seymour & Earle 128* (BRIT, NCU); low wet areas, P.O. Ocean Springs, 11 Jul 1952, *Demaree 32,146* (BRIT); moist pine barrens, P.O. Ocean Springs, 13 Jul 1952, *Demaree 32,199* (NCU); moist sandy areas, P.O. Ocean Springs, 21 Jul 1952, *Demaree 32,273* (BRIT); low slash pine woods scattered with *Myrica, Cyrilla,* and *Ilex*, along Fort Bayou and highway 57 cut-off near highway 57 ENE of Ocean Springs, 22 Jul 1969, *Jones & Catchot s.n.* (MISS); moist ditch banks 9 mi N of Escatawpa, 19 Aug 1952, *Demaree 32,659* (BRIT, MISS); sandy soil of moist low place in pinelands, rte. 63 about 10 mi N of Escatawpa, 9 Aug 1952, *Channell 1,497* (AUA, BRIT); Vancleave, sandy bank of Bluff Creek, 20 Aug 1951, *Channel 451* (MISSA); Ocean Springs, 20 Jul 1955, *Chermock s.n.* (UNA); near the coast, Deer Island, 2 Jul 1952, *Demaree 32,098* (BRIT, NCU); Highway 59 N of Fountainbleau, 6 Jul 1952, *Diener 199* (MISSA); Horn Island, 22 Aug 1947, *Simmons s.n.* (MISS); roadside 1 mi S of county line on highway 57, 22 Jun 1966, *Lowe 196* (GA); 2 mi S of Greene Co. line, highway 63, creek bank, 20 Jun 1966, *Jones 6,803* (MISS); 17 mi S of Lucedale, highway 63, just S of George Co. line at first creek, edge of low slash pine woods, 21 Jul 1969, *Jones 17,147* (BRIT, MISS). **Jefferson Co.:** pasture at Church Hill, loess soil, hilly, weedy, 5 Sep 1966, *Jones & Noble 10248* (MISS). **J ones Co.:** 10 mi S of Laurel on highline right-of-way in disturbed sandy soil, 2 Jul 1963, *Teer s.n.* (BRIT, NCU); low longleaf pine woods, Forest Service road 201, 17 Jun 1966, *Jones & Jones 6720* (MISS). **Lamar Co.:** grassy moist cut-over pineland slope, 3 mi N of Purvis, 26 Jul 1956, *Ray, Jr. 7,187* (BRIT, NCU); near Little Black Creek, 15.5 mi WSW of Hattiesburg, bog area full sun, acid soil, 2 Sep 1964, *Jones 2473* (GA); along Black Creek, highway 589, NNW of Purvis, 11 Jul 1966, *Jones & Jones 7976* (MISS). **Lauderdale Co.:** U.S. 80 crossing of Chunky River, E of Chunky, sandy peaty clearing in loblolly bottom, 22 Aug 1964, *Kral 22,030* (AUA, BRIT). **Leflore Co.:** Greenwood, 9 Jun 1935, *Wenzer 314* (MISSA); NW

of Sidon between Sidon cutoff and old Yazoo River run, in no tillage soybean area, 22 Jun 1998, *Bryson 16426* (MISS). **Marion Co.:** Hugh White Game Management Area, longleaf pine woods, 15 Jun 1966, *Jones, Carter, & Hudson 6575* (MISS). **Oktibbeha Co.:** MAFES research center, low wet area in bermudagrass field, 29 Sep 2002, *Wright 14* (MISSA); **Pearl River Co.:** acid bog 6.5 mi ESE of Lumberton, 6 Jun 1966, *Jones & Jones 6153* (MISS); low roadside ca. 9 mi W of Poplarville, highway 26, 19 Jul 1966, *Jones 8638* (MISS). **Perry Co.:** moist grassy roadside 5 mi E of Runnelstown, 27 Aug 1966, *Jones 9610* (MISS); along Bonhomme & Hattiesburg Southern RR embankment near rich deciduous woods, ca. 11 mi SE of Hattiesburg, 20 Jun 1955, *Ray, Jr. 6243* (MISS, MISSA). **Rankin Co.:** grey sandy clay soil, full sun, well-drained roadside 2,3 mi W of Pelahatchie, highway 90, 13 Jul 1970, *Jones 18939* (MISS). **Simpson Co.:** along Sanders Creek and U.S. route 49, 4.1 mi S of Rankin Co. line, 29 Jul 1968, *Temple 10336* (MISS); low moist roadside, highway 49, 2 mi N of D'Lo, 5 Jul 1967, *Jones 14059* (MISS). **Stone Co.:** pitcher-plant bog, S of University of Mississippi Forest headquarters, 17 Jul 1964, *Pullen 64-1073* (GA, MISS, NCU); headquarters, University of Mississippi forest lands, longleaf pine woods, 18 Jul 1964, *Jones, Jr. 2,178* (NCU). **Washington Co:** 2.5 mi N of Stoneville, Delta Branch Experiment Station, heavy clay soil, 18 Sep 1986, *Gasparini 38* (NLU). **Yalobusha Co.:** alongside Grenada Reservoir, near Bryant, frequently disturbed area, 21 Aug 1998, *Denley 203* (MISS).

North Carolina. Dare Co.: on coastline sand near Salvo, 5 Aug 1955, *Schallert 4007* (BRIT); beach near Manteo, Roanoke Island, 18 Aug 1957, *Schallert 4007* [sic!] (BRIT). **Jones Co.:** on side of county road 1004 near jct. with Island Creek, 5 mi NE of Pollocksville, 24 Jul 1965, Sears C477 (NLU).

Oklahoma. McCurtain Co.: swamp 7 mi S of Eagletown, 13 Oct 1951, *Waterfall 10442* (BRIT).

South Carolina. Berkeley Co.: upper margin of gum pond, now quite dry, with *Pluchea odorata, Ilex myrtifolia*, 5 air mi NE of Honey Hill, 31 Aug 2012, *Nelson 31,310* (USCH); no locality, 22 Sep 1967, *Shriner s.n.* (USCH). **Charleston Co.:** Santee Coastal Reserve, roadside in disturbed wet sand, 6 Jun 1992, *Hill 23,251* (USCH). **Georgetown Co.:** East Bay Street parks facility baseball field and marsh across street, just south of downtown Georgetown near Sampit River, common in moist soil next to ball field, 12 Aug 1993, *Horn & Nelson 7450* (UNA); sprawling on damp sandy ground in pine woods near main gate, Prince George Tract, 3 Aug 1996, *Sekinger 262* (USCH). **Hampton Co.:** Belmont Plantation, grass plain, 11 Jul 1969, *Porcher 72* (USCH). **Horry Co.:** Myrtle Beach, wet sandy places, 2 Aug 1933, *Schallert 3982* (BRIT); Myrtle Beach, sandy soil, 3 Aug 1933, *Schallert 4007* [sic!] (BRIT). **Jasper Co.:** roadside ditch, 1.2 mi S of route 652 on county road S27-58, 9 Sep 1968, *Leonard & Radford 1911* (NLU); wet ground, Jasper State Park, 30 Aug 1988, *Batson s.n.* (USCH). **Orangeburg Co.:** moist bank of North Fork of Edisto River in East Memorial Garden, 14 Aug 1990, *Terrell & Terrell 5,554* (USCH). **Williamsburg Co.:** roadside ditch close to trio, 13 Aug 1978, *LaBorde s.n.* (USCH).

Texas. Cass Co.: 6.5 mi E of Hughes Springs near Black Cypress Creek, 1 Nov 1946, *Whitehouse 17,704* (BRIT). **Freestone Co.:** 14.5 mi S of Fairfield, ditch, 2 Oct 1949, *Turner 1,551* (BRIT). **Galveston Co.:** Galveston Island State Park, low-lying wet flat, 8 Jul 2011, *Rosen & Winzer 5,296* (BRIT). **Harris Co.:** Sheldon Reservoir Road, W side of Reservoir, roadside shell fill and gray clay, 11 Aug 1960, *Traverse 1,629* (BRIT). **Harrison Co.:** Bluebird Cafe lawn, Harleston, 9 Aug 1970, *Cory 57,749* (BRIT). **Jackson Co.:** highway 59 at Navidad River, upper bank of stream, 20 May 1961, *Traverse 2,302* (BRIT). **Jasper Co.:** savannah 2 mi N of Kirbyville, 9 Jun 1946, *Correll & Correll 12,520* (BRIT); roadside 3 mi S of Jasper, 8 Jul 1949, *Cory 56,592* (BRIT). **Newton Co.:** 12.2 mi NNW of Deweyville, 28 Jul 1964, *Shinners 30,309* (BRIT); 12 mi SE of Kirbyville, floodplain of Pecan Lake, 17 Oct 1977, *Ajilvsgi 5,468* (BRIT). **Panola Co.:** 8 mi NW of Carthage, Sabine River bottoms, 16 Aug 1953, *Shinners 15,665* (BRIT). **Red River Co.:** 7.9 mi S of Clarksville, roadside ditch, 30 Sep 1948, *Whitehouse 20,591* (BRIT). **San Augustine Co.:** margin of small lake in pine forest, Angelina National Forest, 19 Sep 1972, *Gould & Leinweber 6,553* (BRIT). **Smith Co.:** 5.5 mi E of Grand Saline, sandy open woods, 6 Jul 1949, *Cory 56,400* (BRIT).

Appendix 2. Collections (12 total) of plants appearing one or more morphological characters of *Diodia harperi* and *D. virginiana*.

ALABAMA. Barbour Co.: *Haynes 6010* (UNA). Leaves are small but fruits measure 6.5–7.5 mm long. **ARKANSAS.** Columbia Co.: electrical right-of-way at Rte. 98, *Thomas 172168* (NLU). Fruits measure 6–7.5 mm, broadly elliptical. **GEORGIA.** Tift Co.: edge of moist roadside ditch W of railroad, 1 mi S of Tifton, 3 Aug 1953, *Duncan, Harper, & Humphrey 17077* (GA). Leaves are short and crowded as in *D. harperi*, but the fruits are elliptical as in *D. virginiana*, and measure 6.0–7.0 mm, an intermediate length between the two species. **KENTUCKY.** Calloway Co.: waste ground part of seep area along Dalton Road E of SR 280, 5 Sep 1990, *McKinney 4564* (BRIT). Leaves are short and crowded, but fruits measure 6-7 mm. **LOUISIANA.** Acadia Par.: LSU Rice Experiment Station E of Rte. 1111, 18 Oct 1975, *Thomas & Allen 47800* (NLU). Leaves are short and crowded, but fruits measure 7–8 mm; edge of dirt road 1 mi. E of Egan, 3 Nov 1962, *Thieret 10127* (BRIT). Leaves are short and crowded, fruits measure 6.0–7.0 mm. Plaquemines Par.: Hebert Research Center, growing atop levee, common, 18 Aug 1991, *Garrison 166* (GA). Leaves match those of *D. harperi*, but fruits measure 6.0–7.0 mm. **MISSISSIPPI.** Clarke Co.: edge of low mixed woods, 2.3 mi NNE of Pachuta, 19 Jul 1967, *Jones & Jones 14567* (GA, MISS). Leaves and fruits are short as in *D. harperi*, but the corolla tubes measure 8.0–10.0 mm, a length matching that of *D. virginiana*. Yalobusha Co.: boat ramp of Grenada Reservoir, 2 Jun 1999, *Denley 752* (MISS). Leaves are shortish (maximum 34 mm), corolla tube is 7.5 mm, and fruit is 6.5 mm long. **SOUTH CAROLINA.** Barnwell Co.: Carolina bay, Station 84, Savannah River Ops. Area, *Batson s.n.* (USCH). Leaves are short and crowded, but fruits measure as much as 7 mm long. **TEXAS.** Harrison Co.: 10.4 mi. WSW of Marshall, 16 Aug 1953, *Shinners 15626* (BRIT). Leaves are short, but fruits measure 6.5–7 mm. Matagorda Co.: roadside ditch bordering rice field, 3 Aug 1956, *Gould 7192* (BRIT). Leaves are short and crowded, but fruits measure 6–7.5 mm.

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INDEX TO UNPUBLISHED "HERBARIUM NAMES" FOR *CASTILLEJA* AND SYNONYMOUS NAMES FROM RELATED GENERA (OROBANCHACEAE)

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ABSTRACT

A listing is provided of unpublished, informal herbarium names associated with the genus *Castilleja* and synonymous names from the genera *Bartsia, Euchroma,* and *Orthocarpus*. This list may prove useful to herbarium personnel and botanical specialists, especially in the determination of the validity of herbarium specimens originally annotated as nomenclatural types.

This paper is intended to provide a reasonably comprehensive list of unpublished, informal, and invalid names associated with the genus *Castilleja* Mutis found as original labels or annotations on specimen sheets in a wide variety of herbaria. Many of these names are found on sheets in multiple herbaria, while others are rarely encountered or found only in a single herbarium. Also included are names originally assigned to other genera, including *Bartsia* L., *Euchroma* Nutt., and *Orthocarpus* Nutt., but whose validly published and ultimately accepted names were subsequently moved to *Castilleja*. This list is intended to assist in the proper identification and disposition of these sheets by herbarium personnel and others wishing to properly identify or sort for storage the large number of accepted species in *Castilleja*. The list should also prove useful in the verification of potential type specimens, as many of the names listed below were originally intended as new species but were never published by their authors or were eventually published under different names. Also included are some names only published as *nomina subnuda* and which are occasionally seen on herbarium sheets, especially those collected by T. Nuttall and listed in synonymy by A. Gray (1862). Most of Nuttall's applicable herbarium names were annotated for inclusion in his genus *Euchroma*. At the time of its publication, Nuttall (1818) included only two species in *Euchroma*. The subsequent herbarium names were evidently intended for inclusion therein but were never validly published. Synonymy for these names should prove useful in the annotation of sheets collected by Nuttall and in clarifying their status as potential type collections.

The publication of any name provided in the present list is in no way intended to result in its effective publication as a nomenclatural or taxonomic entity. The synonymies listed here are based only on herbarium specimens observed by the author for this study. It is possible that a small number of these names were applied to specimens of more than one validly published and accepted species, though I have not seen any cases of this to date, except as noted in the list below. It is also crucial to note that this paper makes no attempt to provide a full synonymy of validly published names in *Castilleja*. Such a synonymy is in preparation and will be presented in a future paper.

This list was compiled during my review and annotation of over 30,000 herbarium sheets of *Castilleja* and related genera, including over 2,000 type sheets of nomenclatural significance, from the following herbaria and a number of additional smaller, agency-related and private collections: ALA, ARIZ, ASC, ASU, BKL, BM, BR, BRIT, CM, CAN, CAS, CGE, CIIDIR, COLO, CPUN, DES, DS, DUKE, E, ENCB, F, G, GH, HAL, HAO, HU, HUT, IA, IA-ISC, ID, IEB, ILL, K, KANU, LIV, LY-BON, LY-GAN, LINN, MICH, MIN, MO, MEXU, MONT, MSC, MT, MW, NA, ND,

NDG, NMC, NO, NY, OKLA, OSC, OSC-ORE, OSC-WILLU, P, PH, RENO, RM, RSA, RSA-POM, S, SD, SJNM, TEX/LL, TUR, UC/JEPS, U, UBC, UCR, UNM, US, USF, UT, UTC, UVSC, V, UVIC, VT, WIS, WS, WTU, YU, Z, and ZEA.

In the following list, the unpublished, synonymous name is given first, along with the name of the person providing that annotated identification, using standard abbreviations where appropriate. The equivalent, validly published, synonymous name follows, along with the author's name. The list is arranged in alphabetical order by unpublished species name. In a few cases, I could not determine the precise identity of the specimen, and this is noted in the listing. The accepted names are determined in accordance with my continuing studies in *Castilleja* and match those found in my publications, including the forthcoming treatment of *Castilleja* in the Flora of North America, Vol. 17. Any corrections and/or emendation to this list would be appreciated by the author.

Castilleja affinis Hook. & Arn. var. *californica* (Abrams) Bacig. = *Castilleja affinis* Hook. & Arn. var. *affinis*
Castilleja alba Pennell = *Castilleja mexicana* (Hemsl.) A. Gray
Castilleja alvarensis Pennell = *Castilleja glandulosa* Greenm.
Castilleja arctica Kryl. & Serg. subsp. *ussensis* Rebr. = *Castilleja arctica* Kryl. & Serg.
Castilleja arvensis Schltdl. & Cham. var. *minor* Conzatti = *Castilleja arvensis* Schltdl. & Cham.
Castilleja atrolabiata Pennell = *Castilleja occidentalis* Torr.
Castilleja attenuata Pennell = *Castilleja integrifolia* L.f. var. *chiapensis* (Brandegee) J.M. Egger
Castilleja bajacalifornica Moran = *Castilleja lanata* A. Gray
Castilleja bipinnata DC. = *Castilleja gracilis* Benth.
Castilleja bipinnata M. Ownbey = *Castilleja chromosa* A. Nelson
Castilleja brachyloba Piper = *Castilleja brevilobata* Piper
Castilleja breedlovei Chuang & Heckard = *Castilleja filiflora* Nesom
Castilleja brevicalyx C.H. Harvey = *Castilleja tenuiflora* Benth. var. *tenuiflora*
Castilleja bryantii Brandegee subsp. *insularis* Moran = *Castilleja socorrensis* Moran
Castilleja caustrina Pennell = *Castilleja nervata* Eastw.
Castilleja chlorantha Pennell = *Castilleja mexicana* (Hemsl.) A. Gray
Castilleja chromosa A. Nelson f. *dubia* (A. Nelson) M. Ownbey = *Castilleja angustifolia* Nutt. var. *dubia* A. Nelson
Castilleja chromosa A. Nelson var. *dubia* (A. Nelson) Pennell = *Castilleja angustifolia* Nutt. var. *dubia* A. Nelson
Castilleja cinerula Pennell = *Castilleja peckiana* Pennell
Castilleja cinerula macrodonta Pennell = *Castilleja peckiana* Pennell
Castilleja citrescens Pennell = *Castilleja angustata* (B.L. Rob. & Seaton) Eastw.
Castilleja confusa Greene var. *pubens* A. Nelson & Macbr. = *Castilleja miniata* Douglas ex Hook. var. *miniata*
Castilleja cuneatus Nutt. = *Castilleja affinis* Hook. & Arn. var. *affinis*
Castilleja davisiana Pennell = *Castilleja rigida* Eastw.
Castilleja digitalis DC. = *Castilleja scorzonerifolia* Kunth
Castilleja diversicolor Pennell = *Castilleja miniata* Douglas ex Hook. var. *miniata*
Castilleja elatior Piper = *Castilleja elata* Piper
Castilleja exerta (or) exserta Eastw. = *Castilleja subinclusa* Greene var. *jepsonii* (Bacig. & Heckard) J.M. Egger
Castilleja exsertiflora Pennell = *Castilleja sessiliflora* Pursh, color form found in Arizona and New Mexico
Castilleja fallax Pennell = *Castilleja elata* Piper
Castilleja fernaldiana Pennell = *Castilleja hispida* Benth. var. *acuta* (Pennell) M. Ownbey
Castilleja flammea Pennell = *Castilleja glandulosa* Eastw., undescribed variety

Castilleja floccosa A. Heller = *Castilleja ambigua* Hook. & Arn. var. *ambigua*
Castilleja folidora Hook. & Arn. = *Castilleja foliolosa* Hook. & Arn.
Castilleja fissifolia L.f. subsp. *fructicosa* ([incor.] Wedd.) Melch. f. *pygmaea* Cuatrec. = *Castilleja nubigena* Kunth
Castilleja fissifolia L.f. var. *junculosa* G. Mandon = *Castilleja nubigena* Kunth
Castilleja flavifasciatus G.L. Neson = *Castilleja jiquilpana* Nesom
Castilleja fulgens Nutt. = *C. linariifolia* Benth.
Castilleja fulva Pennell, not Pennell 1934 = *Castilleja tenuiflora* Benth. var. *xylorrhiza* (Eastw.) Nesom
Castilleja gibba Pennell = *Castilleja pallescens* (A. Gray) Greenm. var. *pallescens*, alpine form
Castilleja glandulosa Brandegee = *Castilleja martinii* Abrams var. *clokeyi* (Pennell) N.H. Holmgren
Castilleja glutinosa Pennell = *Castilleja glandulifera* Pennell
Castilleja grenadina Pennell = *Castilleja tenuiflora* Benth. var. *tenuiflora*
Castilleja guadalupensis Pennell, not Brandegee 1903 = *Castilleja tenuiflora* Benth. var. *xylorrhiza* (Eastw.) Nesom
Castilleja holobracteata Pennell = *Castilleja nervata* Eastw. (or) *Castilleja rigida* Eastw.
Castilleja incana Pennell = *Castilleja galehintoniae* Nesom
Castilleja integra A. Gray f. *flavescens* Pennell = *Castilleja integra* A. Gray (or) *Castilleja kaibabensis* N.H. Holmgren
Castilleja juniperina Pennell = *Castilleja galehintoniae* Nesom
Castilleja kearneyi Pennell = *Castilleja mogollonica* Pennell
Castilleja lanatoides Pennell = *Castilleja lanata* A. Gray
Castilleja lanceolata Dombey = *Castilleja arvensis* Schltdl. & Cham.
Castilleja linearis Pennell (not Rydb. 1901) = *Castilleja virgata* (Wedd.) Edwin
Castilleja lithospermoides Kunth var. *lutea* (S. Wats.) Pringle = *Castilleja nervata* Eastw.
Castilleja livermorensis M.W. Lockwood, (published in thesis form only, M.S. Thesis, Sul Ross St. Univ., 1991.) = *Castilleja integra* A. Gray, "elongata" form
Castilleja macrodonta Pennell = *Castilleja peckiana* Pennell
Castilleja microphylla Benth. = *Castilleja tenuiflora* Benth. var. *tenuiflora*
Castilleja miniata Douglas ex Hook. f. *trifida* Pennell = *Castilleja miniata* Douglas ex Hook. var. *miniata*
Castilleja miniata Douglas ex Hook. f. *pubescens* Pennell = *Castilleja miniata* Douglas ex Hook. var. *miniata*
Castilleja mulickii Pennell = *Castilleja nivea* Pennell & M. Ownbey
Castilleja ochocoensis N.H. Holmgren = *Castilleja rhexiifolia* Rydb.
Castilleja occidentalis Torr. [subsp.?] *intermedia* Pennell = *Castilleja occidentalis* Torr.
Castilleja ortegae Standl. subsp. *pterocaulon* (N.H. Holmgren) Chuang = *Castilleja pterocaulon* N.H. Holmgren
Castilleja pallescens (Nutt.) Greenm. (sic) var. *oresbia* (Greenm.) Ownbey = *Castilleja oresbia* Greenm.
Castilleja paludicola A. Heller = *Castilleja minor* (A. Gray) A. Gray var. *spiralis* (Jeps.) J.M. Egger
Castilleja palustris Pennell = *Castilleja saltensis* Eastw.
Castilleja parryi Pennell = *Castilleja pallescens* (A. Gray) Greenm. var. *pallescens*
Castilleja pilosa (S. Watson) Rydb. var. *jussellii* (Eastw.) Bacig. = *Castilleja pilosa* (S. Wats.) Rydb. var. *pilosa*
Castilleja pinnatifida DC. = *Castilleja gracilis* Benth.
Castilleja pinnatifida Humboldt = *Castilleja fissifolia* L.f.
Castilleja pinnatifida Pennell = *Castilleja patriotica* Fern.
Castilleja pinnatiflora Pennell = *Castilleja patriotica* Fern.
Castilleja practica Pennell = *C. nelsonii* Eastw.
Castilleja prostrata Dombey = *Castilleja pumila* (Benth.) Wedd. ex F.L. Herrera

Castilleja retroflexifolia Pennell = *Castilleja tenuiflora* Benth. var. *tenuiflora*
Castilleja richardsonii Torr. (?) = *Castilleja foliolosa* Hook. & Arn.
Castilleja rubra Pennell = (identity of specimen impossible to determine, but the name is unpublished)
Castilleja salina Pennell = *Castilleja sphaerostigma* Eastw.
Castilleja sanguinea Pennell = *Castilleja perelegans* Nesom
Castilleja saxicola Piper = *Castilleja rupicola* Piper
Castilleja schaffneri Hemsley var. *cinerea* Eastw. = *Castilleja moranensis* Kunth var. *cinerascens* (Eastw.) J.M. Egger
Castilleja septentrionalis Lindl. var. *rhexiifolia* (Rydb.) J.M.Egger = *Castilleja rhexiifolia* Rydb.
Castilleja shinnersiana V.L. Cory = *Castilleja indivisa* Engelm.
Castilleja subulata Sessé & Moç. = *Castilleja integrifolia* L.f.
Castilleja stokesii (or) *stokesiae* Brandegee = *Castilleja chromosa* A. Nelson
Castilleja tenuifolia M. Martens & Galeotti subsp. *aurea* (B.L. Rob. & Greenm.) Chuang = *Castilleja aurea* B.L. Rob. & Greenm.
Castilleja tricolor Pennell = *Castilleja nervata* Eastw.
Castilleja turneri Nesom = *Castilleja rigida* Eastw.
Castilleja undulata (Pennell?) = *Castilleja arvensis* Schltdl. & Cham.
Castilleja undulata Pennell [subsp.?] *glandulosa* Pennell = *Castilleja applegatei* Fern. var. *pinetorum* (Fern.) N.H. Holmgren
Castilleja vanegatis Pennell = *Castilleja galehintoniae* Nesom
Castilleja viscida Rydb. [subsp.?] *galeata* Pennell = *Castilleja miniata* Douglas ex Hook. var. *miniata* (or) *C. applegatei* Fern. var. *viscida* (Rydb.) M. Ownbey
Castilleja vulgaris I. Holmgren = *Castilleja fissifolia* L.f.
Castilleja wascoensis Pennell = *Castilleja xanthotricha* Pennell

Bartsia pallida (L.) Spreng. var. *latifolia* Nutt. = *Castilleja unalaschensis* (Cham. & Schltdl.) Malte

Euchroma albida Nutt. = *Castilleja attenuata* (Benth.) T.I Chuang & Heckard
Euchroma flava Nutt. = *Castilleja cusickii* Greenm.
Euchroma integrifolia Nutt. = *Castilleja miniata* Douglas ex Hook. var. *miniata*
Euchroma lanceolata Nutt. = *Castilleja minor* (A. Gray) A. Gray var. *exilis* (A. Nelson) J.M. Egger
Euchroma laciniata Nutt. = *Castilleja hispida* Benth. var. *hispida*
Euchroma lutescens Nutt. = *Castilleja cuscikii* Greenm.
Euchroma macrocalyx Nutt. = *Castilleja angustifolia* (Nutt.) G. Don var. *angustifolia*
Euchroma pallescens Nutt. = *Castilleja pallescens* (A. Gray) Greenm. var. *pallescens*
Euchroma simplex Nutt. = *Castilleja minor (*A. Gray) A. Gray var. *exilis* (A. Nelson) J.M. Egger
Euchroma villosa Nutt. = *Castilleja angustifolia* (Nutt.) G. Don var. *angustifolia*
Euchroma viscosa Nutt. = *Castilleja applegatei* Fernald var. *viscida* (Rydb.) M. Ownbey

Orthocarpus castillejoides [subsp.?] *purpureotincta* Pennell = *Castilleja ambigua* Hook. & Arn.
Orthocarpus chachapoyensis Pennell = *Castilleja peruviana* Chuang & Heckard
Orthocarpus chlorotica Piper = *Castilleja chlorotica* Piper
Orthocarpus hispidus Benth. var. *tenuis* (A. Heller) Macbr. & Payson = *Castilleja tenuis* A. Heller
Orthocarpus maculatus A. Heller, not Eastw. 1905 = *Castilleja exserta* (A. Heller) Chuang & Heckard x *Castilleja brevistyla* (Hoover) Chuang & Heckard
Orthocarpus orientalis Pennell = *Castilleja laciniata* Hook. & Arn.
Orthocarpus peruvianus Pennell = *Castilleja profunda* Chuang & Heckard

Philypan californica Hartweg = *Castilleja ambigua* Hook. & Arn.

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NEW COMBINATIONS FROM *HELIOTROPIUM* TO *EUPLOCA* (BORAGINALES: HELIOTROPIACEAE) FOR NORTH AMERICAN SPECIES

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ABSTRACT

We provide four new combinations needed for the treatment of *Euploca* (Boraginales: Heliotropiaceae) in a forthcoming volume of the Flora of North America: **Euploca confertifolia** (Torr.) Feuillet & Halse, **comb. nov.**, **Euploca greggii** (Torr.) Halse & Feuillet, **comb. nov.**, and **Euploca tenella** (Torr.) Feuillet & Halse, **comb. nov.**, **Euploca torreyi** (I.M. Johnst.) Halse & Feuillet, **comb. nov.**

The genus *Euploca* Nutt. (Nuttall 1836: 189) was transferred to *Heliotropium* L. (Linnaeus 1753, 1: 130) by Gray (1857: 403). Recently Hilger and Diane (2003) reevaluated the classification of the Heliotropiaceae Schrad. (Schrader 1819: 192) on the base of molecular data of nuclear ITS1 and plastidal *trn*LUAA intron sequences. One of their conclusions is that *Heliotropium* sect. *Orthostachys* (R. Br.) G. Don (Brown 1810: 493; Don 1938: 361), *Schleidenia* Endl. (Endlicher 1839: 646), and *Hilgeria* Förther (1998: 132) constitute a separate genus whose earliest available name is *Euploca*.

Some North American species belonging to *Euploca* have not been transferred from *Heliotropium*. We present the new combinations needed for the treatment of the genus in Flora of North America.

The case of *Heliotropium angustifolium*

Rafinesque (1833: 79) renamed, without good reason, *Heliotropium curassavicum* "Elliott", which is *H. curassavicum* L. (1753, 1: 130) as cited by Elliott (1821: 224): *H. angustifolium* Raf. is illegitimate and rejected, and automatically typified by the type of the name it was intended to replace (McNeill et al., 2012: Art. 52.1. and 2.). Not knowing Rafinesque's name, Torrey (1858: 137) named a different species *H. angustifolium* Torr. We know it excludes the type of *H. curassavicum* because *H. curassavicum* is treated by Torrey on page 136. According to McNeill et al. (2012: Art. 53.1.), *H. angustifolium* Torr. is illegitimate. A century later, Johnston (1959: 13) became aware of *H. angustifolium* Raf. and renamed *H. angustifolium* Torr. as *H. torreyi* I.M. Johnst.

Euploca torreyi (I.M. Johnst.) Halse & Feuillet, **comb. nov.** *Heliotropium angustifolium* Torr., Rep. U.S. Mex. Bound. [Emory], Bot., 137. 1858 nom. illeg. non Raf. 1833 (Herb. Raf. 79, an illegitimate renaming of *H. curassavicum*). *Heliotropium torreyi* I.M. Johnst., Wrightia 2: 13. 1959. **LECTOTYPE** (designated by Johnston 1959: 13): **USA**. **Texas**. [Val Verde Co.]: Zoquete Creek, between Rio Grande and Brackettville, 18 May 1851, *C. Wright 1546* (NY; isolectotypes: BM, F, GH, LE, P!, US!).

Other new combinations in *Euploca*

Euploca confertifolia (Torr.) Feuillet & Halse, **comb. nov.** *Heliotropium limbatum* var. *confertifolium* Torr., Rep. U.S. Mex. Bound. [Emory], Bot., 138. 1858. *Heliotropium confertifolium* (Torr.) Torr. ex A. Gray, Syn. Fl. N. Amer. 2(1): 184. 1878. **LECTOTYPE** (designated by Förther 1998: 203): **USA. Texas**. Pecos Co.: 1 Jul 1852, *C. Wright 1547* (NY; isolectotypes: BM, GH, K, M, P?, US!).

Euploca greggii (Torr.) Halse & Feuillet, **comb. nov.** *Heliotropium greggii* Torr., Rep. U.S. Mex. Bound. [Emory], Bot., 137. 1859. **LECTOTYPE** (designated by Förther 1998: 198): **MEXICO**. [**Chihuahua**]. Valley of Conchos, near Rosalia, 1 May 1847, *J. Gregg s.n.* (NY; isolectotype: GH).

Euploca tenella (Torr.) Feuillet & Halse, **comb. nov.** *Heliotropium tenellum* Torr., in Marcy, Rep. Expl. Red River 304, t. 14. 1853. *Lithospermun tenellum* Nutt., Trans. Amer. Philos. Soc., n. ser. 5: 188. 1836; a later homonym and illegitimate, non Raf. 1819. *Heliotropium nuttallii* House, Bull. N.Y. State Mus. 233/234: 61. 1920; a superfluous renaming. **TYPE** (fide Förther 1998: 233): **USA**. [**Louisiana**]. In the prairies of Red River, Jun 1819, *T. Nuttall s.n.* (holotype: BM; isotype: P! s. coll.).

Nuttall (1836) described *Lithospermum tenellum*, which is a later homonym of Rafinesque's name (1819), so this name by Nuttall is illegitimate. When Torrey (1853) transferred the species to *Heliotropium*, the epithet 'tenellum' was available.

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VASCULAR FLORA OF THE SHOAL CREEK PRESERVE FOREVER WILD TRACT, LAUDERDALE COUNTY, ALABAMA

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ABSTRACT

The Shoal Creek Preserve Forever Wild Tract (SCPFWT) is a 123 ha property acquired by Alabama's Forever Wild Land Program on February 26, 2003. The SCPFWT lies 13 km north-northeast of Florence, Alabama, 46 km southeast of Lawrenceburg, Tennessee, and is bordered for a short distance on the east by Shoal Creek. The site is managed by the Alabama Department of Conservation and Natural Resources for habitat conservation, outdoor recreation, and education. An intensive floristic study of this area was conducted from May 2009 through May 2011 and less frequently through June 2015. A total of 519 taxa from 346 genera and 121 families were collected, with 217 taxa representing county records. Asteraceae was the most collected family, with 69 species; Poaceae, Fabaceae, and Cyperaceae were the next largest families with 38, 29, and 17 species, respectively. *Carex* was the largest genus represented with 11 species. 71 non-native taxa were collected during the surveys. 42 percent of the total collections were county records and 37 exotic taxa collected during this survey were county records. Plant collections were deposited at the Alabama Natural Heritage Section Herbarium (ALNHS) with duplicates and replicates distributed to Anniston Museum of Natural History (AMAL), Jacksonville State University Herbarium (JSU), University of Alabama Herbarium (UNA), and Auburn University Herbarium (AUA).

The Forever Wild Program was established in 1992 by an Alabama constitutional amendment (Satterfield & Waddell 1993) to provide a mechanism for purchasing land from willing landowners for public recreation and conservation of vital habitat. Since its inception, the Forever Wild Program, managed by the Alabama Department of Conservation and Natural Resources (ALDCNR), has purchased more than 100,400 ha (approximately 248,100 acres) of land for general recreation, nature preserves, additions to wildlife management areas, and state parks. For each Forever Wild tract purchased, a management plan providing guidelines and recommendations for the tract must be in place within a year of acquisition. The 123 ha Shoal Creek Preserve Forever Wild Tract (SCPFWT) was acquired on February 26, 2003, in part, through a Land and Water Conservation Fund grant awarded by the Alabama Department of Economics and Community Affairs, as well as financial and in-kind contributions from the City of Florence and Lauderdale County. The SCPFWT is managed by the ALDCNR for habitat conservation, outdoor recreation, and education. This study represents the first systematic inventory of the vascular flora for the tract. The goal of this study was to perform an exhaustive survey of the tract and establish a baseline of the area's biodiversity while recording all vascular plant species and concomitantly documenting county records, introduced plants, and rare species.

STUDY AREA

The 123 ha SCPFWT is located between 34.906-34.922°N and 87.624-87.610°W in rural, central Lauderdale County, AL. The tract lies east of Lauderdale County Road 61 and west of Shoal Creek, which forms an approximately 300 m portion of the eastern boundary. Indiancamp Creek serves as the northeastern boundary of the SCPFWT and the southeastern boundary is delineated primarily by Jones Branch, both streams being tributaries of Shoal Creek (Figure 1).

The SCPFWT lies within the Western Highland Rim Level IV Ecoregion of the Interior Plateau physiographic province and is characterized by irregular plains dissected by gently to steeply sloped hills (Griffith et al. 2001). Elevation on the tract ranges from 156 m to approximately 204 m above sea level. The ultisol soils of the tract are predominated (70%) by mixed, mesophytic hardwood forests with interspersed pines (*Pinus spp.*) and eastern red-cedar (*Juniperus virginiana* L.) along the higher and somewhat drier hilltops. The remaining habitat composition of the tract is composed of fallow fields and ruderal areas (15%), floodplain forests/creek bottoms (10%), and limestone outcroppings (5%) found primarily along the streams. The climate for the area averages a July and August high of 33° C and a January low of -1° C; rainfall for the area is approximately 135 cm (53 inches) per year with December typically being the wettest month and August being the driest (weather.com 2015). The area averages 210 frost-free days per year (Griffith et al. 2001).

The town of St. Florian, formerly known as Wilson Stand, is the closest municipality to SCPFWT and was historically part of a large plantation owned by John and Matthew Wilson. The plantation was purchased by J.H. Heuser, who then sold parcels to German Catholics under the articles of the German Catholic Homestead Association of Cincinnati (Foscue 1989). Land use during the Wilson brothers and subsequent German Catholic ownership was primarily agricultural and the area was often referred to by many of these early settlers as the "garden spot" of the state and even the south. Many of the crops grown included potatoes (Irish and sweet), wheat, corn, cotton, rye, oats, asparagus, and various fruits such as grapes, apples, and peaches. Typically, the crops were rotated with plantings of "Japan clover" and cowpeas as a soil improvement and, in the case of cowpeas, a source of hay. Stock animals such as cattle, pigs, sheep, and poultry were raised on many of the farms (pers. comm., Carl Stumpe).

METHODS

The systematic sampling of the SCPFWT flora was intensively conducted from May 2009 through May 2011 and less frequently through June 2015. The study area was surveyed utilizing a modified meandering method similar to that of Goff et al. (1982). When possible, plants were collected in a manner that was non-destructive (top-snatched) to the populations sampled. Because of the size of the SCPFWT, the natural divisions of the property, and the frequency of survey visits, thorough sampling of the tract was possible. Voucher specimens were collected and identified by the authors. Identifications were subsequently verified by Dan Spaulding, Curator of the Anniston Museum of Natural History and were specimens deposited in the Natural Heritage Section Herbarium (ALNHS). Duplicate and replicate collections were deposited at the Anniston Museum of Natural History Herbarium (AMAL), Jacksonville State University Herbarium (JSU), University of Alabama Herbarium (UNA), and Auburn University Herbarium (AUA).

Plant identifications, comparison of related species, nativity, and county records were determined using the following: *Alabama Plant Atlas* (APA Editorial Committee 2015); *Flora of the Southern and Mid-Atlantic States* (Weakley 2015); *Manual of the Grasses of the United States*. Volumes I and II (Hitchcock 1971); *Manual of the Vascular Flora of the Carolinas* (Radford et al. 1968); *Plant Life of Alabama* (Mohr 1901); and *Floristic Synthesis of North America* (Kartesz 2015). Nesom (2015) was consulted for the *Galactia* determination. Guidelines for construction of this flora followed recommendations outlined by Palmer et al. (1995). Placement of species at the family rank and binomials follow Weakley (2015). Abbreviations for authorities and nativity of species follow Kartesz (2015).

RESULTS AND DISCUSSION

Vegetation Survey Summary

The plant specimens collected from the SCPFWT included a total of 519 taxa, 346 genera, and 121 families, with 217 taxa (42%) ascertained to be county records for Lauderdale County

(Kartesz 2015). Asteraceae was the most collected family with 69 species. Poaceae, Fabaceae, and Cyperaceae were the next most-represented families with 38, 29, and 17 species, respectively. *Carex* was the most-collected genus, represented by 11 species. Flowering plants comprised 95% of the flora, with dicots making up 75% and monocots the remaining 20% (Table 1). Ferns and fern allies followed with 4.5%, and conifers represented 0.5% of the total number of taxa sampled. Seventy-one species, or 13.5%, were introduced species (non-native to North America).

Selected Rare And Notable Plant Species

Several rare, undercollected, or regionally uncommon species were collected from SCPFWT, the most notable being *Platanthera peramoena* (Gray) Gray (purple fringeless orchid), *Pilea fontana* (Lunell) Rydb. (black-seeded clearweed), *Aplectrum hyemale* (Muhl. ex Willd.) Torr. (puttyroot), and *Aralia racemosa* L. (American spikenard). State (S) and global (G) rankings follow those from the Alabama Natural Heritage Program tracking list (Alabama Natural Heritage Program, 2015).

Platanthera peramoena

Inhabiting alluvial forests, stream banks and seepage slopes, floral phenology for *Platanthera peramoena* is typically from late June through early October (Brown 2004, Weakley 2015). *Platanthera peramoena*, a G5/S1 species, occurs as far north as Pennsylvania and Delaware and reaches the southern limit of its distribution in central Alabama and Mississippi (Kartesz 2015). This locally rare species is currently known from only two counties in Alabama (APA Editorial Committee 2015, Kartesz 2015; NatureServe 2015). Although the species had previously been reported from Lauderdale County (collected in 1896) another population along Little Butler Creek had recently been discovered (APA Editorial Committee 2015). This collection represents a previously unknown population and occurs on conservation land.

Pilea fontana

Occurring in wetland habitats, including floodplain forests, seepages and freshwater marshlands, *Pilea fontana* (black-seeded clearweed) G5/S1 was previously reported from only two Alabama counties (Kartesz 2015). The first collection was made in 1978 by R.K. Godfrey from Houston County with a second report from a bottomland ravine near Hurricane Creek in Jackson County (Schotz 2014). Further, *Pilea fontana* has been vouchered from only two Florida counties, one unvouchered report from a single Georgia county, and is not currently known from Mississippi or Tennessee (Kartesz 2015). *Pilea fontana* is an herbaceous annual with a wide distribution throughout the Midwest to the Northeast but is considered uncommon to rare in the southern USA. Black-seeded clearweed occurs sympatrically with *Pilea pumila* (L.) Gray and can easily be misidentified for its more common counterpart; however, when mature, black-seeded clearweed can easily be distinguished by its dark purplish-black, pebbled achenes (Weakley 2015).

Aplectrum hyemale

The solitary inflorescence of *Aplectrum hyemale* G5/S2 is often a similar color to that of the surrounding forest floor leaf litter making it difficult to locate. However, the solitary plicate leaf with its white stripes is more easily detected in the rich woodlands and bottomlands and along deciduous slopes where this species occurs (Brown 2004). Flowering typically occurs from April to mid-May when the leaves begin to senesce for the season (Brown 2004; Weakley 2015). This species occurs throughout much of eastern North America and reaches the southern limit of its distribution in Alabama (Brown 2004; Kartesz 2015; NatureServe 2015). Currently this species has been reported from five Alabama counties (APA Editorial Committee 2015; Kartesz 2015).

Aralia racemosa

Aralia racemosa is typically found in rich, mixed deciduous woodlands. Spikenard is a G4/S1 species that has been historically harvested, particularly the roots, for its medicinal properties (NatureServe 2015). It is a large herb, growing to 2m, with large compound leaves. Flowering

occurs from June to August with the small white flowers held in clustered umbels (NatureServe 2015; Weakley 2015). This eastern North American species reaches the southern limit of its distribution in northern Alabama, currently known from six counties (APA Editorial Committee 2015; Kartesz 2015).

Exotic Plant Species

Thirty-seven (52%) of the 71 non-native plant taxa collected were considered county records for Lauderdale County (Kartesz 2015). The percentage of exotics collected (13.5%) during this study is similar to that found in other floras conducted in the state (Table 2). Other Alabama floras yielded the following percentages of exotics: the 1785 ha Red Hills Forever Wild Tract yielded 11% non-natives (Barger & Holt 2015); the 1,216 ha Old Cahawba Forever Wild Tract yielded 19% non-natives (Barger et al. 2014); the 7365 ha Perdido River Forever Wild Tract yielded 11% non-natives (Barger et al. 2013); the 240 ha Indian Mountain Forever Wild Tract yielded 11% non-natives (Barger & Holt 2010); the 130 ha Coon Creek Forever Wild Tract yielded 7% non-natives (Barger & Tenaglia 2008); 2528 ha Lake Guntersville State Park yielded 17% non-natives (Spaulding 1999); the 28,329 ha Talladega Ranger District in Talladega National Forest yielded 12% non-natives (Ballard 1995); and 1101 ha Cheaha State Park yielded 10% non-natives (Bussey 1983). While this study did not focus on quantitative measurements of the exotic plant coverage, the observed land area covered by these non-native plants was restricted to primarily ruderal or disturbed areas of the tract. The most commonly encountered non-native plant species, in order of relative abundance, were *Ligustrum sinense* (Chinese privet), *Daucus carota* (Queen-Anne's-lace), *Lonicera japonica* (Japanese honeysuckle), the combined *Trifolium* spp. (clovers) and *Vicia* spp. (vetches), and *Albizia julibrissin* (silktree).

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Table 1. Summary of vegetation surveys performed on the Shoal Creek Preserve Forever Wild Tract by Divisions, Flowering Plant Class, Family, Genus and Species. Nativity of species refers to North America.

				Total			Non-native
			Total	Taxa	Native	Non-native	Taxa
Division/Class	Families	Genera	Taxa	Composition %	Taxa	Taxa	Composition %
Lycopodiophyta	2	2	2	0.5	2	0	0.0
Polypodiophyta	12	18	21	4.0	20	1	0.1
Pinophyta	2	2	4	0.5	4	0	0.0
Magnoliophyta	105	324	492	95	424	70	13.4
Class Liliopsida	19	63	104	20	79	26	5.0
Class Magnoliopsida	86	261	388	75	345	44	8.4
TOTAL	**121**	**346**	**519**	**100**	**450**	**71**	**13.5**

Table 2. Percentage of exotic species from selected vascular floras conducted on state or federally owned land in Alabama. Study sites marked with an asterisk in the following table were conducted by the authors of this study.

Study Site	% Exotics
Coon Creek FW Tract*	7.0%
Cheaha State Park	10.0%
Indian Mtn. FW Tract*	11.0%
Perdido FW Tract*	11.0%
Red Hills FW Tract*	11.0%
Talladega Ranger District	12.0%
Solon Dixon Center	13.0%
Shoal Creek FW Tract*	13.5%
Guntersville State Park	17.0%
Old Cahawba FW Tract*	19.0%

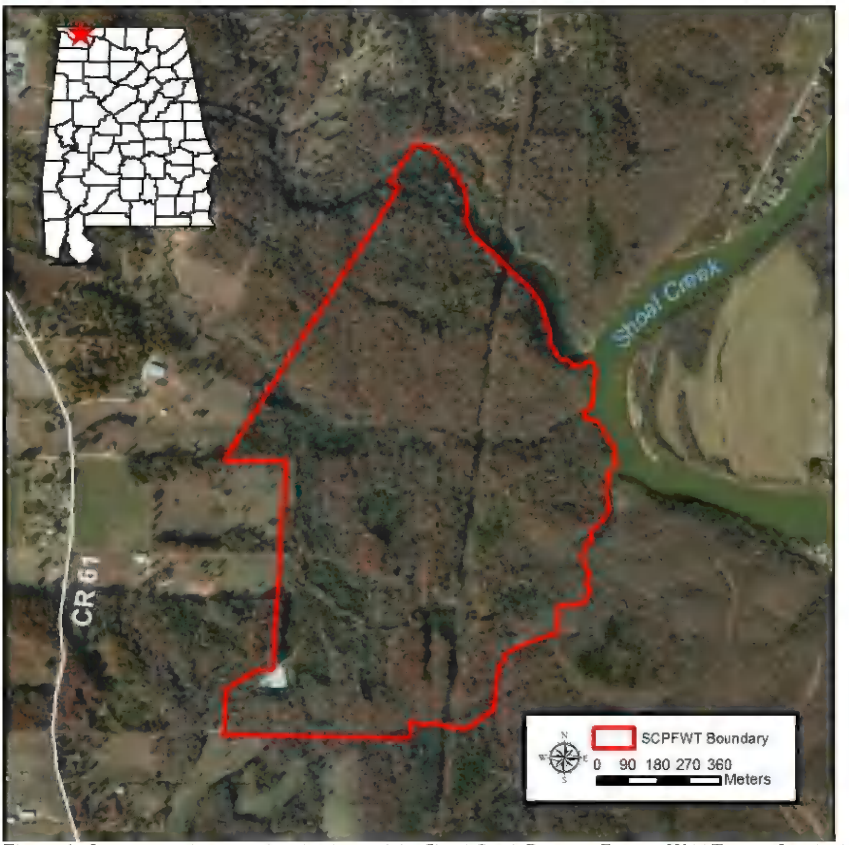

Figure 1. Location and surrounding land use of the Shoal Creek Preserve Forever Wild Tract in Lauderdale Co., Alabama.

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Appendix 1. Annotated checklist of the vascular flora of the Shoal Creek Preserve Forever Wild Tract, with breakdown of the survey by taxa level and native versus non-native species.

As previously mentioned, the nomenclature follows Weakley (2015) with abbreviations for the authorities following Kartesz (2015). The United States Department of Agriculture's Plants Database website (USDA NRCS 2015) was also referenced for additional synonyms and common names (for labels). Arrangement of the checklist is by division, then alphabetically by family, genus, and specific epithet. Species followed with a dagger (†) after the collection number are considered non-native species to the flora; those followed by an asterisk (*) are species of special concern or are considered state rare; and those followed by a double dagger (‡) were determined to be county records. Collection numbers listed are not lifetime collection numbers, but rather are specific to the current flora of the SCPFWT. The collection numbers in the list below are recorded as such on the vouchered specimens, i.e. *Asplenium trichomanes* L. subsp. *trichomanes* SC264, *Sorghastrum nutans* (L.) Nash SC516, etc.

LYCOPODIOPHYTA (Quillworts, Clubmosses, and Spikemosses)
LYCOPODIACEAE Clubmoss Family
Diphasiastrum digitatum (Dill. ex A. Braun) Holub 006

SELAGINELLACEAE Spikemoss Family
Lycopodioides apodum (L.) Kuntze 406

MONILOPHYTA (Horsetails and Ferns)
ASPLENIACEAE Spleenwort Family
Asplenium platyneuron (L.) B.S.P. 094
Asplenium rhizophyllum L. 265
Asplenium trichomanes L. subsp. *trichomanes* 264 ‡

ATHYRIACEAE Lady Fern Family
Athyrium asplenioides (Michx.) A.A. Eaton 368
Deparia acrostichoides (Swartz) M. Kato 203 ‡

CYSTOPTERIDACEAE Brittle Fern Family
Cystopteris protrusa (Weatherby) Blasdell 513 ‡

DIPLAZIOPSIDACEAE Glade Fern Family
Homalosorus pycnocarpos (Spreng.) Pichi-Sermolli 514

DRYOPTERIDACEAE Wood Fern Family
Polystichum acrostichoides (Michx.) Schott 222

ONOCLEACEAE Sensitive Fern Family
Onoclea sensibilis L. var. *sensibilis* 250

OPHIOGLOSSACEAE Adder's Tongue Fern Family
Botrypus virginianus (L.) Michx. 050
Ophioglossum pycnostichum (Fern.) A. & D. Löve 083
Sceptridium dissectum (Spreng.) Lyon 007 ‡

OSMUNDACEAE Royal Fern Family
Osmunda spectabilis Willd. 354

Osmundastrum cinnamomeum (L.) K. Presl 505

POLYPODIACEAE Polypody Family
Pleopeltis michauxiana (Weatherby) Hickey & Sprunt 125

PTERIDACEAE Maidenhair Fern Family
Adiantum capillus-veneris L. 454
Adiantum pedatum L. 283

THELYPTERIDACEAE Marsh Fern Family
Macrothelypteris torresiana (Gaud.) Ching 251 †
Parathelypteris noveboracensis (L.) Ching 413
Phegopteris hexagonoptera (Michx.) Fée 328

WOODSIACEAE Woodsia Family
Woodsia obtusa (Spreng.) Torr. 366

CONIFEROPHYTA (Gymnosperms)
CUPRESSACEAE Cypress Family
Juniperus virginiana L. var. *virginiana* 022

PINACEAE Pine Family
Pinus echinata P. Mill. 450
Pinus taeda L. 200
Pinus virginiana P. Mill. 108

MAGNOLIOPHYTA (Flowering Plants)
ACANTHACEAE Acanthus Family
Justicia americana (L.) Vahl 102
Ruellia caroliniensis (J.F. Gmel.) Steud. 344

ADOXACEAE Moschatel Family
Sambucus canadensis L. 066
Viburnum rufidulum Raf. 302

ALISMATACEAE Water-plantain Family
Sagittaria latifolia Willd. var. *latifolia* 381

ALLIACEAE Onion Family
Allium canadense L. var. *canadense* 221 ‡
Allium vineale L. 427 † ‡

ALTINGIACEAE Sweet-gum Family
Liquidambar styraciflua L. 027

AMARYLLIDACEAE Amaryllis Family
Hymenocallis occidentalis (LeConte) Kunth 157 ‡
Narcissus ×medioluteus P. Mill. (pro sp.) 318 †
Narcissus pseudonarcissus L. 252 † ‡

ANACARDIACEAE Cashew Family
Rhus copallinum L. var. *copallinum* 084
Rhus glabra L. 059
Toxicodendron radicans (L.) Kuntze var. *radicans* 223

ANNONACEAE Custard-apple Family
Asimina triloba (L.) Dunal 154

APIACEAE Carrot Family
Chaerophyllum tainturieri Hook. 279
Cicuta maculata L. var. *maculata* 369
Cryptotaenia canadensis (L.) DC. 331
Daucus carota L. 081 †
Erigenia bulbosa (Michx.) Nutt. 267
Osmorhiza longistylis (Torr.) DC. 315
Oxypolis rigidior (L.) Raf. 197 ‡
Ptilimnium capillaceum (Michx.) Raf. 363 ‡
Sanicula canadensis L. var. *canadensis* 176
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe 324 ‡

APOCYNACEAE Dogbane Family
Amsonia tabernaemontana Walt. var. *tabernaemontana* 325 ‡
Asclepias tuberosa L. subsp. *tuberosa* 082
Gonolobus suberosus (L.) R. Brown var. *suberosus* 068

AQUIFOLIACEAE Holly Family
Ilex decidua Walt. 519
Ilex longipes Chapman ex Trel. 430 ‡
Ilex opaca Ait. var. *opaca* 085

ARACEAE Arum Family
Arisaema dracontium (L.) Schott 295
Arisaema triphyllum (L.) Schott 052
Lemna valdiviana Phil. 451

ARALIACEAE Ginseng Family
Aralia racemosa L. 153 ‡*
Aralia spinosa L. 073
Hedera helix L. var. *helix* 320 † ‡
Panax quinquefolius L. 305 ‡*

ARISTOLOCHIACEAE Birthwort Family
Asarum canadense L. 049
Endodeca serpentaria (L.) Raf. 053
Isotrema tomentosum (Sims) H. Huber 056 ‡

ASTERACEAE Aster Family
Ageratina altissima King & H.E. Robins. var. *altissima* 245 ‡
Ambrosia artemisiifolia L. 148 ‡
Ambrosia trifida L. 143 ‡
Antennaria solitaria Rydb. 260

Arnoglossum reniforme (Hook.) H.E. Robins. 339
Artemisia annua L. 362 † ‡
Bidens aristosa (Michx.) Britt. 172 ‡
Bidens bipinnata L. 147 ‡
Bidens frondosa L. 405 ‡
Brickellia eupatorioides (L.) Shinners 496 ‡
Chrysopsis mariana (L.) Ell. 416 ‡
Cirsium discolor (Muhl. ex Willd.) Spreng. 401 ‡
Cirsium vulgare (Savi) Ten. 372 † ‡
Conoclinium coelestinum (L.) DC. 167 ‡
Coreopsis lanceolata L. 448 ‡
Doellingeria infirma (Michx.) Greene 171 ‡
Elephantopus carolinianus Räusch. 168
Elephantopus tomentosus L. 093 ‡
Erechtites hieraciifolius (L.) Raf. ex DC. 371 ‡
Erigeron annuus (L.) Pers. 008 ‡
Erigeron strigosus Muhl. ex Willd. var. *strigosus* 177 ‡
Eupatorium album L. 162 ‡
Eupatorium capillifolium (Lam.) Small 187 ‡
Eupatorium hyssopifolium L. 129 ‡
Eupatorium rotundifolium L. 128 ‡
Eupatorium serotinum Michx. 199 ‡
Eutrochium fistulosum (Barratt) E.E. Lamont 390 ‡
Helenium amarum (Raf.) H. Rock var. *amarum* 099 ‡
Helenium autumnale L. 522 ‡
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THE TROPICAL MADREAN FLORA OF YÉCORA, SONORA, MEXICO

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ABSTRACT

The Municipio de Yécora is in the Tropical Madrean zone of the Sierra Madre Occidental in eastern Sonora, Mexico. The flora is very diverse with 1777 taxa in 150 families and 687 genera. The most important families and genera are Asteraceae (14.5% of the flora), Poaceae (11.3%), and Fabaceae (10.6%), *Muhlenbergia* (38 taxa), *Euphorbia* (31 taxa), *Cyperus* (29 taxa), *Ipomoea* (26 taxa), *Quercus* (23 taxa including 7 hybrids), and *Dalea* (22 taxa). Herbaceous plants dominate the flora (71.3%). Twenty-one species in the Yécora flora have protection in NOM-059-SEMARNAT-2010. Non-native species are 6.2% of the flora but only buffelgrass (*Pennisetum ciliare*) in the tropical lowlands and Natal grass (*Melinis repens*) in grassland and oak woodland are invasive in natural habitats.

Vegetation is zoned from foothills thornscrub and tropical deciduous forest in the lowlands to oak woodland and pine-oak forest in the uplands. Plant species diversity increases with elevation and rainfall, peaking in pine-oak forest. The Yécora flora in the Madrean Tropical Madrean zone serves as a baseline to evaluate Madrean affinities in floras in the Madrean Archipelago in northeastern Sonora and southeastern Arizona.

RESUMEN

El Municipio de Yécora se localiza en la zona Madrense Tropical de la Sierra Madre Occidental al este de Sonora, México. La flora es muy diversa, con 1777 taxones en 150 familias y 687 géneros. Las familias y géneros más importantes son Asteraceae (14.5% de la flora), Poaceae (11.3%) y Fabaceae (10.6%), *Muhlenbergia* (38 taxones), *Euphorbia* (31 taxones), *Cyperus* (29 taxones), *Ipomoea* (26 taxones), *Quercus* (23 taxones, incluye 7 híbridos) y *Dalea* (22 taxones); y las plantas herbáceas dominan la flora (71.3%). Veintiuna especies de la flora de Yécora tienen protección federal en la NOM-059-SEMARNAT-2010. Las especies introducidas representan el 6.2% de la flora, pero sólo el zacate búfel (*Pennisetum ciliare*) en las partes bajas tropicales y el zacate rosado (*Melinis repens*) en pastizales y encinales son invasoras de hábitats naturales.

La vegetación se divide en zonas de matorral espinoso de piedemonte y selva baja caducifolia en las partes bajas, hasta encinales y bosques de pino encino en las partes altas. La diversidad de la flora aumenta con la altitud y la precipitación, con la mayor riqueza en el bosque de pino encino. La flora de Yécora es típica de la zona Madrense Tropical y sirve como referencia para evaluar las afinidaes madrenses en las floras del Archipiélago Madrense del noreste de Sonora y sureste de Arizona.

INTRODUCTION

Sierra Madre Occidental

The Sierra Madre Occidental extends from Zacatecas and Jalisco north to Chihuahua and Sonora in western Mexico (Rzedowski 1978). The Continental Divide follows the Sierra Madre northward to the Sierra Huachinera on the Chihuahua-Sonora border, and then through the isolated Sierra el Púlpito and Sierra San Luis in Sonora and the Animas Mountains in southwestern New Mexico. The Madrean Archipelago is the region of isolated Sky Island mountain ranges between the northern Sierra Madre Occidental in Sonora and Chihuahua and the Mogollon Rim of central Arizona (Lowe 1992; McLaughlin 1995; Warshall 1995; Fig. 1A & B). González-Elizondo et al. (2012) defined the floristic divisions of the Sierra Madre Occidental. The Madrean Tropical zone is on the northwestern crest of the Sierra Madre above tropical vegetation on the Pacific slopes. Floras of the Sky Islands are extensions of both Madrean Tropical and Northern Madrean floristic divisions (González-Elizondo et al. 2012).

Warshall (1995) recognized 40 Sky Island mountain ranges with crowns of oak woodland and pine-oak forest in the Madrean Archipelago based on the Brown and Lowe (1982) vegetation map. A new GIS-based analysis identified 55 Sky Islands and Sky Island complexes of ranges connected by oak woodland corridors in the Madrean Archipelago, 23 in Arizona and New Mexico and 32 in Sonora and Chihuahua (Deyo et al. 2013; Van Devender et al. 2013a).

In this paper, we discuss the Tropical Madrean flora of the Municipio de Yécora in the Sierra Madre Occidental in eastern Sonora in regional floristic and phytogeographic contexts.

BACKGROUND

Previous Floristic Studies

Howard Gentry's Río Mayo Plants (1942) was a major contribution to the knowledge of the flora of northwestern Mexico. The Río Mayo Region included a broad area in southern Sonora and adjacent Chihuahua in the Ríos Fuerte, Mayo, and Yaqui drainages in both lowland tropical vegetation and upland temperate woodlands and forests of the Sierra Madre Occidental. The completion of Mexico Federal Highway 16 (MEX 16) in 1992 greatly increased access to the northern Sierra Madre Occidental in Sonora and Chihuahua (Búrquez et al. 1992). A revision of the Río Mayo flora by Martin et al. (1998) recorded a total of 2,835 taxa and incorporated the Madrean floras of the Cascada de Basaseáchi (Spellenberg et al. 1996) and Nabogame (Laferriére 1994), Chihuahua.

Stephen S. White of the University of Michigan led three botanical expeditions to explore northeastern Sonora in 1938-1941, (White 1948). His collections in the Sierra El Tigre were the first intensive inventory of a major Sky Island mountain range in Sonora. Fishbein et al. (1995) presented a preliminary flora of the Sierra de los Ajos, a high-elevation range near Cananea.

History of collections

The Río Mayo Region of Gentry (1942) includes the Yécora area in the Río Yaqui drainage, but difficulty of access prevented him from reaching there. Later, he went to Santa Ana on the southwestern edge of the Mesa del Campanero in November 1958. Richard F. Felger collected in the Yécora area in June 1955 and December 1959. Campbell W. Pennington conducted ethnographic studies of the Mountain Pima Indians in El Kípor and Maycoba east of Yécora in July 1968 (with Timothy Dunnigan) and August 1970. His plant collections are in the University of Texas herbarium in Austin.

Raymond M. Turner and J. Rodney Hastings, coauthors of "An Atlas of Some Plant Distributions in the Sonoran Desert" (Hastings et al. 1972), made Yécora area collections in October 1969; in May 1975 with Annetta Carter, Reid Moran, George Cummins, and G. Culver and also in

August 1985 with Paul S. Martin. Deborah E. Goldberg made extensive collections in the Santa Ana and Santa Rosa areas with Stephen P. McLaughlin and Turner as part of her dissertation on vegetation and flora of hydrothermally-altered soils on gossans in 1975-1977 and 1980 (Goldberg 1982, 1985). In March 1975, Martin led an expedition from the University of Arizona to cross the Sierra Madre Occidental through Yécora to the Cascada de Basaseáchi in Chihuahua. Martin returned to Mesa del Campanero with George M. Ferguson in May 1988, March 1990, and July 1992.

With the completion of MEX 16, which connects Hermosillo, Sonora, and Ciudad Chihuahua, floristic knowledge of the Yécora area and the northwestern Sierra Madre Occidental increased dramatically, and was included in the revised flora in Gentry's Río Mayo Plants (Martin et al. 1998). Mark Fishbein, Michelle McMahon, Ferguson, Felger, and Michael F. Wilson collected extensively in the Yécora area in July 1994. Van Devender and Reina-Guerrero began an intensive inventory of the flora of the Municipio de Yécora in 1995 (Reina-G. et al. 1999). About 180 botanists have been on collecting trips in the Yécora area. Except for individual species descriptions, our publications on the flora of the Ciénega de Camilo (Van Devender et al. 2003) and the sedges and grasses of the Municipio de Yécora (Roalson et al. 2002; Van Devender et al. 2005) are the first for the Yécora area.

The Madrean Archipelago Biodiversity Assessment (MABA) program was initiated by Sky Island Alliance in 2009 to accumulate biological records from the Sky Islands Region in Sonora and Chihuahua. The Madrean Discovery Expeditions (MDE) program at GreaterGood.org was created in 2015 to continue biotic inventories in the Madrean Archipelago. There were nine expeditions to Sonoran Sky Islands where large groups of biologists documented animals and plants, plus smaller inventory trips to ten additional mountain ranges. A preliminary flora of the Sierra Bacadéhuachi was based on inventories on four trips in 2011-2012 (Van Devender et al. 2013b). This range, located 165 km north of the Yécora area, has been considered either a southern Sky Island or a western extension of the Sierra Madre Occidental. All of these records from MABA and MDE inventories and many high-resolution images are publicly available in the MABA (madrean.org) and MDE (madreandiscovery.org) databases for use in conservation, research, and education. The FLORA parts of these databases are directly linked to the Southwest Environmental Information Network (SEINet, swbiodiversity.org/seinet/), which contains locality information on 4.2 million regional herbarium specimens and 802,000 images from the southwestern USA and northwestern Mexico.

Study Area and Inventories

MEX 16 provides an elevational transect through the Municipio de Yécora from lowland tropical vegetation to highland montane forests (Fig. 2A & B). The Municipio is an area of 3,300 km2. Most of the Municipio is in the Río Yaqui drainage; only the southeastern edge of Mesa del Campanero is in the Río Mayo watershed. Elevation in the Municipio ranges from 480 m along Arroyo Tepoca near Curea to 2,150 m on Mesa del Campanero, an increase of 1,770 meters in 27 kilometers (by air). Regional base level is 160 m elevation along the Río Yaqui at Ónavas west of the Municipio de Yécora.

Between May 1995 and August 2008, and again in August 2012, we visited the Yécora area 36 times in all seasons. The flora is based on 8100 plant collections (6567 by Van Devender and Reina-G.). Label information for most of the collections is available online in the MABA/SEINet databases. Specimens were deposited into herbaria at the University of Arizona (ARIZ), Universidad de Sonora (USON), Universidad Nacional Autónoma de México (MEXU), Arizona State University (ASU), New Mexico State University (NMC), Centro de Investigaciones Biológicas del Noroeste (HCIB), University of Texas (TEX), Missouri Botanical Garden (MO), Rancho Santa Ana Botanical Garden (RSA), Instituto de Ecología del Bajío (IEB), and others.

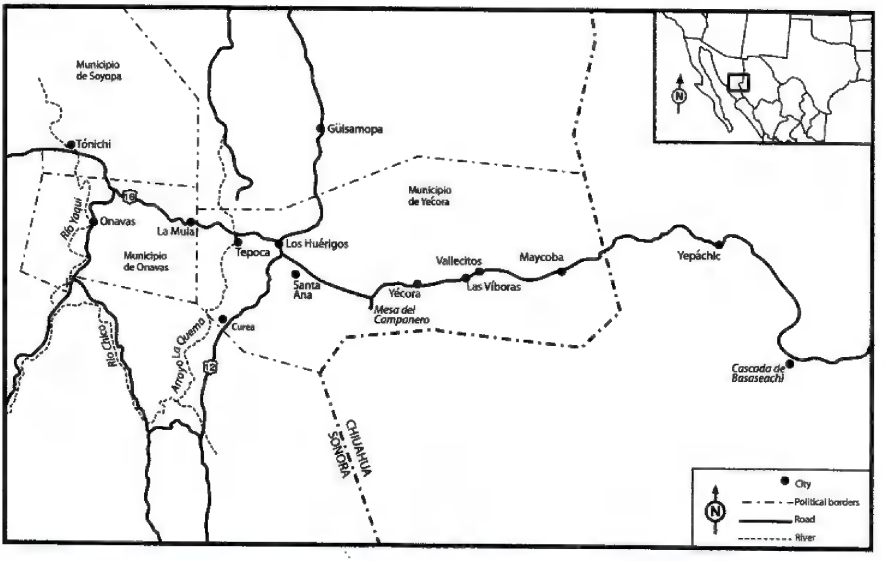

Figure 1A. Map of Sonora and the Yécora region by Gerald Dawavendewa.

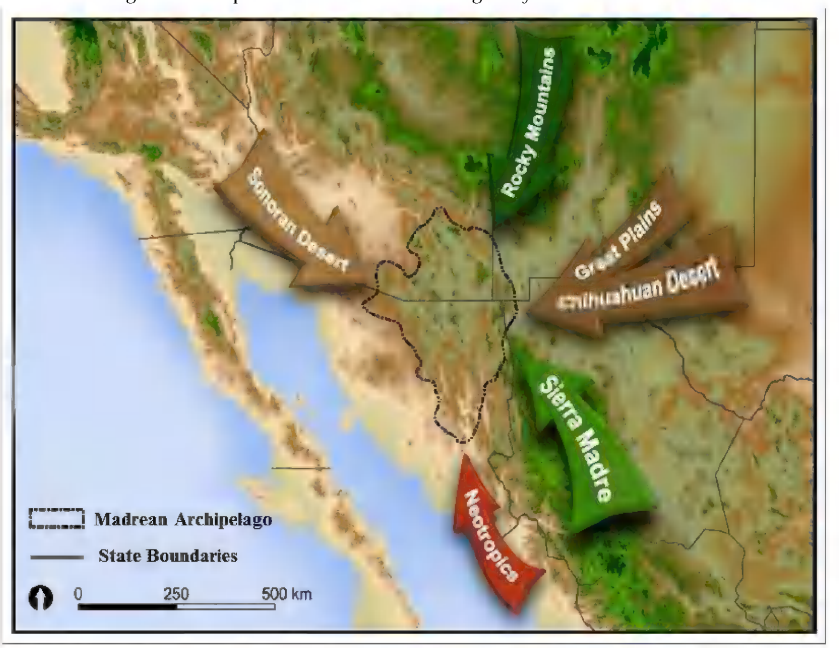

Figure 1B. Map of the convergence zone of five biotic provinces in the Madrean Archipelago. Map by Nick Deyo, Sky Jacobs, and Van Devender.

Floristic Analyses

The Yécora flora has a total of 1777 taxa in 150 families and 687 genera. The families with the most species are Asteraceae (257 taxa, 14.5% of the flora), Poaceae (200 taxa, 11.3%), and Fabaceae (188 taxa, 10.6%). The grasses were summarized in Van Devender et al. (2005). These families plus 14 others with 20 or more taxa (Table 1) make up 65.3% of the flora. Asteraceae, Poaceae, and Fabaceae are typically the most important families in North American floras, with Fabaceae dominant in tropical deciduous forest. In the Municipio de Yécora, the numbers of species of Asteraceae and Poaceae increase with elevation in more temperate areas. Ferns and allied plants are diverse with 15 families, 31 genera, and 78 taxa (4.4%; Yatskievych et al. 2010). The importance of Euphorbiaceae (3.2%), Convolvulaceae (2.5%), Solanaceae (2.5%), Malvaceae (2.1%), Rubiaceae (1.8%), Apocynaceae (including Asclepiadaceae, 1.7%), and Orchidaceae (1.5%) in the flora reflects the influence of the New World tropics.

Muhlenbergia (38 taxa), *Euphorbia* (31 taxa), *Cyperus* (29 taxa), *Ipomoea* (26 taxa), *Quercus* (23 taxa including 7 hybrids), and Dalea (22 taxa) are especially diverse genera. These genera plus eleven others with 11 or more taxa represent 18.2% of the flora. With eleven species, *Pinus* is relatively diverse.

Plant nomenclature follows Gentry's Río Mayo Plants (Martin et al. 1998), the flora of Sonora appendix in Van Devender et al. (2010), the Taxonomic Thesaurus in SEINet (http://swbiodiversity.org/portal/index.php), and personal choices. Names, synonyms, and authors were checked in Missouri Botanical Garden's Tropicos taxonomic website (http://www.tropicos.org/).

Life forms. The Yécora flora has a wide range of life forms (Table 2). Woody plants, including shrubs (8.9% of the flora), trees (7.5%), subshrubs (4.4%), woody vines (1.8%), and woody parasites (0.4%) make up 23.1% of the flora. The vegetation of the Municipio de Yécora, with the exception of montane grasslands, is dominated by trees, which are relatively minor components in the flora. Succulents including cacti and *Agave* and its relatives account for 2.5% of the flora. The majority (71.3%) of the plants in the flora are herbs, with more perennials (43.9%) than annuals (27.4 %). The importance of annual dicots in the Yécora flora is relatively low (338 taxa, 19.0%) compared to Mohave Desert floras in California and Sonoran Desert floras in southwestern Arizona and northwestern Sonora, where annual dicots comprise 40-50% of local floras. Moreover only 13.3% of the annual dicots are obligatory winter-spring species, reflecting the distance from the North Pacific Ocean and decreasing importance of rainfall from winter frontal storms. Grasses and sedges account for 14.5% of the flora, with more perennials (9.0%) than annuals (5.5%). Ferns and their relatives are common herbs (4.4%). Aquatic herbs (0.6%) are both perennial and annual as are parasitic plants (0.8%). Vines are common (6.1%) in the flora and include woody lianas, herbaceous perennials, and annuals, especially Ipomoea (1.5%).

Non-native species. A total of 111 taxa (6.2%) in the Yécora flora is introduced from elsewhere. Non-natives are most common in the Poaceae (31 taxa), Brassicaceae (7 taxa), Asteraceae (6 taxa), and Fabaceae (5 taxa). The percentages of non-natives is very low in all habitats, reflecting low levels of disturbance, i.e., foothills thornscrub (1.2%), tropical deciduous forest (3.0%), oak woodland (2.2%), grassland (0.9%), and pine-oak forest (3.5%). Non-natives often follow roadways or are most common near houses and in gardens. The higher numbers of non-natives in tropical deciduous forest and pine-oak forest partially reflects the locations of the main settlements in those areas.

Most non-native species are not invasive with little impact on native species or vegetation. Mustards are widespread in the study area but not dense in any area. The only invasive species in the Municipio de Yécora are buffelgrass/*zacate búfel* (*Pennisetum ciliare*) in the tropical lowlands and Natal grass/*zacate rosado* (Melinis repens) in grassland and oak woodland. Hindi grass (*Dichanthium*

annulatum) is a common invasive in the Álamos area that recently was introduced into Arizona (Felger et al. 2005). It is only present in a few areas in tropical deciduous forest in the Municipio de Yécora but is potentially invasive in tropical lowland vegetation.

Non-natives that are widespread but not invasive include Bermuda grass/zacate inglés (*Cynodon dactylon*), black mustard/*mostaza* (*Brassica nigra*), and London rocket/pamitón (*Sisymbrium irio*). South American tree tobacco/*juan loco* (*Nicotiana glauca*) is not common but occurs as high as 1900 m elevation in pine-oak forest at Puerto de la Cruz. Castor bean/*higuerilla* (*Ricinus communis*) is occasional in the tropical lowlands but is invasive in other areas in Sonora (Van Devender et al. 2009). Today it is widespread in Sonora, especially in warmer areas, but Gentry (1942) did not report it from the Río Mayo Region.

A cultivated tobacco with pink flowers called *papante* (*Nicotiana tabacum*) is well established in the Mountain Pima Indian village of El Kípor. Chinaberry tree/*piocha* (*Melia azederach*) was formerly used as an ornamental tree in lowland towns. It is now established in tropical riparian forests near Curea, La Quema, San Nicolás, and Santa Rosa, and in montane forests along MEX 16 near Maycoba and Yécora. Peach/*durazno* (*Prunus persica*) following MEX 16 westward from Chihuahua has reached Puerto de la Cruz west of Yécora.

Lantana/*confitería negra* (*Lantana camara*) with orange and red flowers is native to the tropical lowlands in the Municipio, but a cultivar (*L. camara* var. "*mozelle*") with pink and yellow flowers was encountered in pine-oak forest along MEX 16 west of Yécora.

Neither species of tamarisk/*pino salado* (*Tamarix aphylla, T. chinensis*) are common in the Municipio, although they are invasive in other parts of Sonora (Van Devender et. al. 2009).

Vegetation

Vegetation zonation. There are important changes in vegetation with elevation that are most easily seen along MEX 16 from Tepoca to the Chihuahua border (Fig. 2A). The transition between the New World tropics and the northern temperate zone is at about 29°N in east-central Sonora. Foothills thornscrub (*matorral espinoso*) is a very important biotic community in Sonora that is transitional between Sonoran desertscrub and tropical deciduous forest in southern Sonora and oak woodland in eastern Sonora (Van Devender et al. 2013c). In the Municipio de Yécora, thornscrub only occurs in a limited area at 460-550 m elevation in a rain-shadow valley at Curea (Fig. 3A). Dominants include *tepeguaje* (*Lysiloma watsonii*), *torotes* (*Bursera fagaroides* var. *elongata, B. laxiflora*), *papelío* (*Jatropha cordata*), *palo chino* (*Havardia mexicana*), tree morning glory/*palo blanco* (*Ipomoea arborescens*), tree ocotillo/*ocotillo macho* (*Fouquieria macdougalii*), organpipe cactus/pitahaya (*Stenocereus thurberi*), and tropical cholla/*siviri* (*Cylinodropuntia thurberi*).

In the Municipio, tropical deciduous forest (*selva baja caducifolia*) is found in a broad band at 500-1160 m elevation. Dominants include most of the same species in foothills thornscrub plus *mauto* (*Lysiloma divaricatum*), *torotes* (4 additional species), figs/*higueras* (5 species), *amapa morada* (*Tabebuia impetiginosa*), kapok/*pochote* (*Ceiba acuminata*), *palo zorillo* (*Senna atomaria*), and *etcho* (*Pachycereus pecten-aboriginum*; Fig. 3B). Two oaks, including Chihuahua oak/*cusi peludo* (*Quercus chihuahuensis*) and *encino* (*Q. tuberculata*), occur locally in tropical deciduous forest.

In the Yécora area, oak woodland (*encinal*) is present at 1050-1700 m elevation. Dominants include oaks (*Quercus arizonica, Q. oblongifolia*, plus 8 other species, and 5 interspecific hybrids), Chihuahua pine/*pino chino* (*Pinus chihuahuana*), and alligator juniper/*táscate* (*Juniperus dep*peana). At 1220-2240 m, oak woodland often occurs in a mosaic with pine-oak forest (*bosque de pino encino* Fig. 4A). Pine-oak forest dominants include most of the same trees as oak woodland plus additional

Figure 2A. Highway MEX 16 was finished in 1992. Photo by Erik F. Enderson.

Figure 2B. Mesa del Campanero. Photo by Erik F. Enderson.

Figure 3A. Foothills thornscrub near Curea. Photo by Van Devender.

Figure 3B. Tropical deciduous forest near Santa Ana. Photo by Mark A. Dimmitt.

Figure 4A. Oak woodland near Los Pilares. Photos by Van Devender.

Figure 4B. Pine-oak forest near Yécora. Photo by Erik F. Enderson.

Figure 5A. Mixed-conifer forest in Barranca el Salto on Mesa del Campanero. Photo by George M. Ferguson.

pines (*P. arizonica, P. engelmannii, P. yecorensis*, plus 6 other species) and Arizona madrone/*madroño* (*Arbutus arizonica*; Fig. 4B). High elevation pine-oak species include southwestern white pine/*piñón* (*P. strobiformis*), oaks (*Q. durifolia, Q. jonesii*, and *Q. mcvaughii*), and *madroño* (*A. xalapensis*). Mixed-conifer forest (*bosque de coníferas mixtas*) with Durango fir/*pinabete duranguense* (*Abies durangensis*) restricted to Barranca El Salto and two other areas on Mesa del Campanero at 1900-2100 m are the only examples of that vegetation type in Sonora (Fig. 5A & B).

Figure 5B. Durango fir (*Abies durangensis*). Photo by George M. Ferguson.

Grassland (*pastizal*) occurs in high valleys at 1200-1700 m, often in a mosaic with oak woodland or pine-oak forest. Grassland also occurs in the broad Yécora Valley. The Yécora grassland is dominated by a diverse mixture of native perennial herbs, including grasses (42 species) and composites (56 species).

Special habitats. Riparian areas bisect all other vegetation types in the Municipio. Dominant riparian trees in tropical vegetation include *guásima* (*Guazuma ulmifolia*) and willows/*sauces* (*Salix bonplandiana, S. goodingii, S. taxifolia*). Mexican bald cypress/*sabino* (*Taxodium distichum* var. *mexicanum*) is at Tepoca. Velvet ash/*fresno (Fraxinus velutina*), Arizona walnut/*nogal* (*Juglans major*), and *sabino* (*Juniperus blancoi* var. *mucronata*) are locally common riparian trees in oak woodland. Arizona alder/*alamillo* (*Alnus oblongifolia*), bigtooth maple/*haya* (*Acer grandidentatum*), Gentry cherry (*Prunus gentryi*), and Mexican white cedar/*sabino* (*Cupressus lindleyi*) are locally common in pine-oak forest riparian canyons, while hophornbeam/*palo prieto* (*Ostrya virginiana*) and Mexican basswood (*Tilia americana* var. *mexicana*), and Mexican hollies (*Ilex rubra, I. tolucana*) are rare. Wetlands include the Ciénega de Camilo, a peat/*musgo* (*Sphagnum palustre*) spring mound in a riparian canyon in pine-oak forest 1550 m elevation at east of Maycoba (Van Devender et al. 2003; Fig. 6A). There are marshy wetlands on the south edge of Yécora that are disappearing as the town expands.

Figure 6A. *Sphagnum palustre* in the Ciénega de Camilo east of Maycoba. Photo by Doug Danforth.

Figure 6B. Barren areas near Yécora on the volcanic mudflow deposits of the Baucarit Formation. Photo by Van Devender.

Volcanic mudflow deposits of the Báucarit Formation form barrens near Yécora (Fig. 6B). This is a very unusual habitat that supports widely scattered oaks and pines or no woody plants at all, even though 913 mean annual mm/yr rainfall (Búrquez et al. 1992) is adequate to support pine-oak forest. Mudflow deposits intercalated between volcanic rocks in the Yécora area were deposited in the middle Miocene age (17.0-17.6 mya, million years ago; Cochemé & Demant 1991) at the beginning of the tectonism that transformed northwestern Mexico, including the Yécora Valley, and the southwestern USA into the modern Basin and Range Province (Cochemé & Demant 1991). The mudflow surfaces in the Yécora Valley likely formed later in the Miocene (R. Scarborough, pers. comm., 1998). From July through September, heavy rainfall keeps the mudflow surfaces wet and a diverse dwarf herb flora flourishes including sedges (10 species in 7 genera), succulents (*Agave polianthiflora, Echinocereus stoloniferus* var. *tayopensis*, *Mammillaria wrightii* var. *wilcoxii, Phemeranthus marginatus,* and *Sedum vinicolor*), grasses (*Microchloa kunthii, Muhlenbergia annua, M. shepherdii*, and *M. texana*), legumes (*Aeschynomene americana* var. *glandulosa*, *Dalea confusa, D. filiformis*, and *Stylosanthes humilis*), and six endemic plants (see below).

Another unusual habitat in the Municipio de Yécora is the gossans, hydrothermally-altered volcanic areas with bright red or yellow acidic soils (pH as low as 4, Fig. 7A). Islands of open pine-oak forest or oak woodland are surrounded by tropical deciduous forest (Goldberg 1982, 1985). Notable low elevation stands of montane trees include Chihuahua oak at 650 m on volcanic soils near La Concepción; Yécora pine/*pino colorado* (*Pinus yecorensis*), and Chihuahua and willowleaf/*cusi* (*Quercus albocincta*; Fig. 7B) oaks at 900 m elevation at Agua Amarilla; Chihuahua pine, Chihuahua

oak, and encino at 820 m west of Santa Ana; eggcone pine/*pino chomonqui* (*P. oocarpa*) at about 1000 m between San Nicolás and the turn off to Santa Ana; stripbark alligator juniper/*táscate* (*Juniperus deppeana* var. *patoniana*) at 900 m north of San Nicolás; and hand basin oak/*güeja* (*Q. tarahumara*) at 1020 m near Santa Rosa.

Figure 7A. Gossan at Agua Amarilla west of Tepoca. Photo by Van Devender.

Figure 7B. *Cusi* (*Quercus albocincta*) from Cerros Colorado near Álamos. Photo by Van Devender.

DISCUSSION

The largest area of Tropical Madrean forests is in the northwestern Sierra Madre Occidental from Yécora to the Huachinera area in eastern Sonora. The flora of the Municipio de Yécora with 1777 taxa is very diverse. It serves both to characterize Madrean Tropical floristic division of the Sierra Madre Occidental, and as a baseline to evaluate the Madrean contribution to Sky Island floras in the Madrean Archipelago (Reina-G. and Van Devender 2005; Van Devender et al. 2013a, b).

Madrean Archipelago flora

McLaughlin (1995) estimated the number of plants in 12 mountain ranges in southeastern Arizona to be 627 species per flora on average, with 33-50% of the regional flora in each of the larger ranges. He estimated 2100 species occur in the Sky Island Region of southeastern Arizona, or 42.1% of the 4212 taxa documented in SEINet for Arizona (Lesley Landrum, pers. comm. 2013). McLaughlin (1995) estimated 2300 to 2800 plant taxa for the entire Sky Island Region, but the total is probably higher because plant species diversity increases southward in New World tropical vegetation and in the Sierra Madre Occidental.

The flora of the state of Sonora with an area of 184,934 km² presently includes 3790 species and infraspecific taxa documented by herbarium specimens (Van Devender et al. 2015, unpublished data). Considering that plant species diversity is highest in Sonora in tropical deciduous forest and Madrean woodlands and forests, perhaps 60-70% of the state flora occurs in the eastern third of the state. The Yécora flora with 1777 taxa makes up more than half of the Madrean Archipelago flora and 46.9% of the Sonoran flora.

Species diversity gradient

Diversity in the Yécora flora increases with elevation; i.e. 313 taxa in foothills thornscrub, 795 taxa in tropical deciduous forest, 839 taxa in oak woodland, and 1121 taxa in pine-oak forest. Several factors influence these numbers. The area of foothills thornscrub is limited to a small area around Curea. West of the Municipio, thornscrub is widespread, supporting many additional species (Van Devender et al. 2013c). Grassland in the Yécora area only has 328 taxa, reflecting its secondary role as openings in oak woodland and pine-oak forest.

MEX 16 is a dispersal corridor for species in the Municipio de Yécora. The Mountain Pima Indians said that willow ragwort/*ruina* (*Barkleyanthus salicifolius*) was not in El Kípor prior to the construction of MEX 16, but has moved from Chihuahua as far west as Puerto de la Cruz west of Yécora. Tropical species move to higher elevations into Madrean vegetation during warmer periods. Examples include boatthorn acacia/*güinolo* (*Acacia cochliacantha*) at 1700-1720 m elevation in pine-oak forest west of Puerto de la Cruz and at Barranca Honda, and sweet acacia/*vinorama* (*A. farnesiana*) at 1700-1820 m elevation on the north slopes of Mesa el Campanero. However, the extreme freeze of February 2011 likely killed most of these lowland plants.

Endemism

Between 1977 and 2014, 29 plant taxa were described from the Municipio de Yécora (Table 3), 20 of them based on collections from this study. Fourteen species are endemic to the Municipio, including *Dalea analiliana, Echinocereus laui, Erigeron reinana,* and *Stevia reinana.* Other new species such as *Boerhavia traubae, Mammillaria saboae* var. h*audeana, Menodora yecorana, Pectis vandevenderi, Portulaca yecorensis,* and *Tridax yecorana* are restricted to the Báucarit Formation mudflow barrens. *Eleocharis yecorensis* was described from the marshy wetlands near Yécora (Roalson 1999), but was later determined to have a wider distribution in the Sierra Madre Occidental (M.S. González-E., pers. comm. 2000).

Although the rhetoric commonly used in Arizona describes the Sky Island mountain ranges as evolutionary arenas for speciation, their floras differ from true insular floras in high species diversity,

low local and regional endemism, and low percentages of non-native species (McLaughlin 1995). New species are discovered much more often in the Yécora area in the mainland Sierra Madre Occidental than in any of the Sky Islands.

Protected species

Twenty-one species in the Yécora flora are legally protected by the Mexican government in the Norma Oficial Mexicana, NOM-059-SEMARNAT-2010 (Diario Oficial de la Federación 2010; Table 4). *Litsea glaucescens* var. *subsolitaria* and *Tilia americana* var. *mexicana* have *Peligro* (P, endangered) status. Seven species are *Amenazada* (A, threatened): *Agave parviflora* subsp. *densiflora*, *A. polianthiflora, Echinocereus lauii, Juglans major, Tabebuia chrysantha, T. impetiginosa* (as *T. palmeri*), and *Trifolium wormskjioldii* var. *ortegae*. Twelve other species are *Protegida* (Pr, special protection).

Biogeography

The oak woodlands and pine-oak forests are very similar in appearance in the Madrean Tropical Sierra Madre Occidental and the Sky Island mountain ranges throughout the Madrean Archipelago, reflecting widespread dominant trees and shrubs. Reina-G. & Van Devender (2005) compared the floras of the Yécora area and the Huachuca Mountains, one of the most diverse Sky Island ranges in Arizona (Bowers & McLaughlin 1996). But only 40% or less of the Sky Island floras actually occur in the mainland Sierra Madre Occidental as temperate and desert plants increase in importance northward. The Yécora flora is about 30% richer than any Sky Island.

The Madrean Archipelago is a convergence zone for five biotic provinces (Van Devender et al. 2013a; Fig. 1B), i.e., the cold temperate Rocky Mountains and Colorado Plateaus to the north, the Great Plains grasslands/Chihuahuan desertscrub to the east, Sonoran desertscrub to the west, and Neotropical vegetation and Sierra Madre Occidental tropical temperate forests to the south. On the west side of North America, the transition between the New World tropics and the northern temperate zone is at about 29°N in east-central Sonora. Tropical deciduous forest is (or was formerly) widespread along the Pacific coast from Costa Rica northwest to the Sierra San Javier (28°35'N), west of the Río Yaqui 80 km west-northwest of Yécora (Van Devender et al. 2010). The northern limits of thornscrub are at about 30°30'N in the Ríos Bavispe and Sonora valleys (Van Devender 2013c), but quite a few thornscrub plants cross the border into southern Arizona in desert grassland or oak woodland.

In contrast, the main influences on the Yécora area are the Neotropics and the Sierra Madre Occidental. Northern cold temperate species are rare, but include bracken fern/*seri* (*Pteridium aquilinum*) and striped wintergreen (*Chimaphila maculata*). Northern grassland elements include *calabacilla de burro* (*Apodanthera undulata*) and pink throat morning glory/*trompillo rastrero* (*Ipomoea longifolia*). The absence of species from other biotic province is more than offset by increasing diversity to the south in both lowland and montane biotic communities. This is primarily related to warmer winter temperatures and reduced frequencies of hard freezes. Desert grassland, which is widespread in the southwestern USA and northeastern Sonora, supports a moderately diverse flora (McClaran & Van Devender 1995), but is not present in the Yécora area. The southernmost remnant desert grassland occurs in the Sierra de Bacadéhuachi (29°45'N, Van Devender et al. 2013b), 165 km north of Yécora. In the Arizona Sky Islands, the maximum species diversity is in the middle elevations in the desert grassland-oak woodland ecotone and lowest in the high elevation pine-oak forests. However, Rzedowski (1978) found that in the Sierra Madre Occidental in Mexico the highest species diversity is in pine-oak forest, as it is in the Yécora area.

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Table 1. Important families and genera in the Yécora flora.

Families (17 families – 1161 taxa [65.3%]

Asteraceae - (257 taxa, 14.5% of the flora)
Poaceae – 200 taxa (11.3%)
Fabaceae – 188 taxa (10.6%)
Cyperaceae – 61 taxa (3.4%)
Euphorbiaceae – 57 taxa (3.2%)
Convolvulaceae - 45 taxa (2.5%)
Solanaceae – 45 taxa (2.5%)
Scrophulariaceae – 43 taxa (2.4%)
Lamiaceae – 40 taxa (2.2%)
Malvaceae 37 - taxa (2.1%)
Pteridaceae – 35 taxa (2.0 %)
Rubiaceae – 32 taxa (1.8%)
Orchidaceae – 27 (1.5%)
Asclepiadaceae – 26 (1.5%) (+ 5 taxa Apocynaceae = 31 taxa [1.7%])
Cactaceae – 25 taxa (1.4%)
Brassicaceae – 23 taxa (1.3%)
Onaceaceae – 20 taxa (1.1%)

Genera (17 genera – 324 taxa [18.2%])

Muhlenbergia – 38 taxa (2.1%)
Euphorbia – 31 taxa (1.7%)
Cyperus – 29 (1.6%)
Ipomoea – 26 taxa (1.5%)
Quercus – 23 (1.3%, 7 hybrids)
Dalea – 22 taxa (1.2%)
Brickellia – 16 taxa (0.9%)
Cheilanthes – 15 taxa (0.8%)
Erigeron – 15 taxa (0.8%)
Salvia – 15 taxa (0.8%)
Solanum – 15 taxa (0.8%)
Stevia – 15 taxa (0.8%)
Bidens – 14 taxa (0.8%)
Physalis – 14 taxa (0.8%)
Paspalum – 13 taxa (0.7%)
Pseudognaphalium – 12 taxa (0.7%)
Pinus – 11 taxa (0.6%)

Table 2. Life forms in the Yécora flora (1777 taxa).

Life Form	# taxa	% taxa
Trees	133	7.5
Shrubs	159	8.9
Subshrubs	78	4.4
Woody vines	32	1.8
Woody parasites	8	0.4
Stem succulents	26	1.5
Rosette succulents	19	1.1
Ferns and allies	78	4.4
Perennial dicot herbs	495	27.8

Epiphytes	4	0.2
Herbaceous perennial vines	42	2.4
Herbaceous perennial parasites	2	0.1
Perennial grasses/sedges	160	9.0
Annual grasses/sedges	98	5.5
Annual dicots	338	19.0
Annual parasites	5	0.3
Annual vines	35	2.0
Aquatic herbs	11	0.6

Total woody plants: 410 (23.1%)
Total succulents: 45 (2.5%)
Total herbs: 1268 (71.3%)
Total perennial herbs: 781 (43.9)
Total annual herbs: 487 (27.4%)
Total grasses/sedges: 258 (14.5%)
Total vines: 109 (6.1%)
Total parasites: 15 (0.8)

Table 3. Taxa described from the Municipio de Yécora. * = endemic to Municipio.

1. *Dalea pinetorum* Gentry var. *pinetorum* - Barneby (1977)
2. **Echinocereus laui* G.R.W. Frank - 1978
3. **Mammillaria saboae* var. *haudeana* (Lau & Wagner) Glass & R. Foster - 1979
4. **Ageratina yecorana* B.L. Turner - 1987
5. **Arceuthobium yecorense* Hawksworth & Wiens - 1989
6. *Hymenocallis pimana* Laferrière - 1990
7. **Pectis vandevenderi* B.L. Turner - 1995
8. *Pinus yecorensis* Debreczy & Rácz - 1995
9. **Tridax yecorana* B.L. Turner - 1995
10. *Euphorbia pionosperma* V.W. Steinm. & Felger - 1997
11. **Menodora yecorana* T. Van Devender & B.L. Turner - 1997
12. *Mimulus yecorensis* Vickery - 1997 (now *Erythranthe pallens* (Greene) Nesom)
13. *Dasylirion gentryi* Bogler - 1998
14. **Erigeron reinana* G.L. Nesom - 1998
15. *Hymenocallis clivorum* Laferrière -1998
16. *Boerhavia traubae* Spellenb. - 1999
17. *Eleocharis yecorensis* E.H. Roalson - 1999
18. **Portulaca yecorensis* Henrickson & T. Van Devender - 1999
19. *Juniperus mucronata* R.P. Adams - 2000 [now *J. blancoi* Martínez var. *mucronata* (R.P. Adams) Farjon]
20. *Polypodium praetermissum* Mickel & Tejero - 2004
21. *Woodsia cystopteroides* Windham & Mickel - 2004
22. **Dalea analiliana* Spellenberg - 2007
23. **Agave parviflora* Torr. subsp. *densiflora* G. Starr & T.R. Van Devender - 2011
24. *Brickellia enigmatica* B.L. Turner - 2011
25. **Lepechinia yecorana* Henrickson, Fishbein, and T. R. Van Devender - 2011
26. **Adenophyllum yecoranum* B.L. Turner -2013
27. **Stevia reinana* B.L. Turner - 2013
28. *Astragalus martinii* Spellenb., T. R. Van Devender & P. D. Jenkins - 2014
29. *Quercus barrancana* Spellenb. - 2014

Table 4. Species in the Yécora flora protected in the Norma Oficial Mexicana, NOM-059-SEMARNAT-2010 (Diario Oficial de la Federación 2010). P: in danger of extinction, A: threatened, and Pr: special protection.

Family	Species	Category
Agavaceae	*Agave parviflora* Torr. subsp. *densiflora* G. Starr & T.R. Van Devender	A
Agavaceae	*Agave polianthiflora* Gentry	A
Agavaceae	*Yucca grandiflora* Gentry	Pr
Arecaceae	*Brahea nitida* Andre	Pr
Betulaceae	*Ostrya virginiana* (Mill.) Koch.	Pr
Bignoniaceae	*Tabebuia chrysantha* (Jacq.) G. Nicholson subsp. *chrysantha*	A
Bignoniaceae	*Tabebuia impetiginosa* (Mart.) Standl. [*T. palmeri* Rose]	A
Bixaceae	*Amoreuxia palmatifida* Moc. & Sessé	Pr
Cactaceae	*Echinocereus lauii* G.R.W. Frank	A
Cactaceae	*Echinocereus stoloniferus* W.T. Marshall var. *tayopensis* (W.T. Marshall) N.P. Taylor	Pr
Cactaceae	*Mammillaria saboae* Glass var. *haudeana* (A.B. Lau & K. Wagner) Glass & R.C. Foster	Pr
Cupressaceae	*Cupressus lusitanica* Mill.	Pr
Fabaceae	*Trifolium wormskjioldii* Lehm. var. *ortegae* (Greene) Barneby	A
Juglandaceae	*Juglans major* (Torr.) A. Heller	A
Lauraceae	*Litsea glaucescens* Kunth var. *subsolitaria* (Meissn.) Hemsl.	P
Malvaceae	*Tilia americana* L. var. *mexicana* (Schltdl.) Hardin	P
Melanthiaceae	*Anticlea virescens* (Kunth) Rydb. [*Zigadenus virescens* (Kunth) J.F. Macbr.]	Pr
Poaceae	*Tripsacum zopilotense* Hernandez X. & Randolph	Pr
Rubiaceae	*Crusea coronata* B.L. Rob. & Greenm.	Pr
Rubiaceae	*Crusea hispida* (Mill.) B.L. Rob. var. *hispida*	Pr
Zygophyllaceae	*Guaiacum coulteri* A. Gray	Pr

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NOTES ON *PHILADELPHUS* (HYDRANGEACEAE)

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ABSTRACT

Philadelphus texensis S.Y. Hu and *P. ernestii* S.Y. Hu (Hydrangeaceae, subg. *Deutzioides*) both occur in central Texas and adjacent northern Mexico (Coahuila). They are primarily distinguished by the presence of an understory of more slender, crinkled hairs on the adaxial leaf surface in *P. texensis* that is absent in *P. ernestii*. Due to their overall similarity and variation exhibited by that key character, they are here treated as *P. texensis* var. *texensis* (including *P. texensis* var. *coryanus*) and **P. texensis** var. **ernestii** (S.Y. Hu) Henrickson, **comb. et stat. nov.** A lectotype is designated for *P. texensis*. **Philadelphus microphyllus** A. Gray var. **pumilus** (Rydb.) Henrickson, **comb. nov**. (replacing *P. microphyllus* var. *stramineus* (Rydb.) Henrickson), accounts for the autonymic establishment of the epithet 'pumilus' at varietal rank.

In 1956 Shiu-Ying Hu published in her monumental taxonomic monograph of the genus *Philadelphus* (Hu 1954-1956) three closely related taxa from the Hill Country of central Texas: *P. ernestii* S.Y. Hu, *P. texensis* S.Y. Hu, and *P. texensis* var. *coryanus* S.Y. Hu.

The above taxa are widely branched, multistemmed shrubs 0.5–1(–2) m tall, with slender, ± sparsely strigose-sericeous stems. Leaves are opposite, lanceolate to lance-ovate, 1–3(–4.7) cm long, 0.5–1(–2.3) cm wide, entire, acute to rounded (when shorter) at the tips, cuneate to sometimes rounded at the bases above petioles 2–7 mm long. The lateral buds are produced axillary to the petiole (not in pockets below the petiole base as in *Philadelphus microphyllus*). The 4-merous flowers are solitary and terminal on central and lateral branches. The pedicels, hypanthia (that cover the lower portion of the ovary — there is no hypanthial tube above the ovaries) and sepals are green, sparsely sericeous-strigose or glabrous. Sepals are valvate, acute-acuminate, 2.5–5.5 mm long. Petals are white, oblong-ovate to ovate, 8–14 mm long, 3.5–5(–10) mm wide, ± entire, obtuse-rounded to acute, sometimes notched (by splitting) at the tip. Stamens are 11–24 in number, with short, thickish, separate, white filaments, but in (older?) flowers, filaments can become purple at the base with this color continuing to the petal bases. The ± half-inferior ovaries have 4 carpels, their styles combine into a central clavate structure 1.5–2.8 mm long with a short, slender base and a much broader terminal portion 1.0–1.6 mm long that bears the 4 broadly linear stigmatic structures that extend up and sometimes beyond the central style column. The loculicidal, turbinate capsules are 3–6 mm diameter, bear the persistent sepals and contain numerous, elongate, slender-fusiform seeds that are rounded (not caudate) at the distal end (Fig. 1. a-d).

The plants commonly occur in open, rocky limestone slopes where they are not crowded out by other shrubs. In moist, shaded conditions the plants can be quite large; in drier conditions they are smaller, sometimes more twiggy with thicker leaves.

Within *Philadelphus*, these plants fall within subg. *Deutzioides* S.Y. Hu, in which Hu recognized three sections, eight species, and seven varieties. Sect. *Hirsutus* Rydb. consists of *P. hirsutus* Nutt. (including *P. sharpianus* S.Y. Hu), which has larger flowers with styles 3–4(–6) mm long, larger, often serrate leaves, and a distribution from North Carolina to Tennessee and Arkansas. Sect. *Serpyllifolius* S.Y. Hu, with *P. texensis* of central Texas and Mexico (central Coahuila) and *P.*

serpyllifolius A. Gray of trans-Pecos Texas and Mexico, has shorter styles 1.5-2.5 mm long, and shorter, entire, sericeous-strigose leaves, with the adaxial leaf surface also having an understory vestiture of more slender, tightly crinkled hairs. Sect. *Pseudoserpyllifolius* S.Y. Hu, with *P. ernestii* of central Texas and Mexico (northern Coahuila) and *P. mearnsii* H.W. Evans ex Rydb. (including *P. hitchcockianus* S.Y. Hu) of southern New Mexico again has smaller flowers with styles only 1.5–2.8 mm long, smaller, entire leaves that are sericeous-strigose on both surfaces — they lack an understory vestiture of more slender hairs.

Of the above-noted species, the eastern *Philadelphus hirsutus* is a larger shrub, with larger, often toothed leaves, and with flowers borne in terminal clusters of 1–3(–5). It is morphologically distinct and geographically isolated from the Texas plants. The central Texas *P. ernestii* has smaller, entire leaves and smaller, usually solitary flowers. The more westerly *P. texensis* is similar to *P. ernestii*, differing primarily in having an understory vestiture of slender, crinkled hairs that are also present in the still more western *P. serpyllifolius*. *Philadelphus serpyllifolius*, however, is distinguished in being both strigose and hirsute (with many erect hairs) on the upper leaf surface.

In all these taxa larger hairs form a sericeous to strigose vestiture of long, tapered, antrorsely oriented, unicellular hairs (Fig 2. a-b). The outer hair surfaces are verrucose, with scattered nipple-like projections covering the surface. They range from 0.3-1.5 mm in length and to 20–33 µm in basal diameter, and they can be abruptly curved above slender bases or more gradually curved; when the walls are thick they are straight, when thinner, they are more wavy in orientation. The more slender, understory hairs, present only in sect. *Serpyllifolius*, are also verrucose and range from 3–5.5 µm in diameter and are so crinkled that the length cannot be determined (Fig. 2b).

The three taxa named by S.Y. Hu, referred to above, are distinguished primarily in the distribution of hairs on the leaves and hypanthia. In all three taxa the upper (adaxial) leaf surface has a sparsely sericeous-strigose vestiture consisting of verrucose hairs 0.3–0.7(–1.0) mm long, to 17–28 µm in thickness. The hairs are usually strongly appressed and number 1–3 per 1 mm of leaf width. On the abaxial (lower) surface the hairs are longer (0.3–1.5 mm) to 15–33 µm thick, closely or loosely appressed, often somewhat wavy when the walls are thinner, but more dense, numbering 6–14 per 1 mm of leaf width (Fig. 2a).

In plants of *Philadelphus texensis*, the abaxial leaf surface also has a close understory vestiture of very slender, thin-walled, verrucose crinkled hairs as previously noted (Fig. 2b).

When initially proposed by Hu (1956), *Philadelphus ernestii* was known from two collections by Ernest Palmer from Kendall Co., Texas. Vestiture of the abaxial (lower) leaf surfaces consisted of only the larger, elongate, variously appressed-wavy hairs. The hypanthia-sepals were also sparsely strigose-sericeous. *Philadelphus texensis* var. *texensis*, initially known from five collections from Bexar to Edwards cos., Texas, differed in its lower leaf vestiture consisting of an overstory of loosely appressed larger hairs and an understory of the above-noted slender, crinkled hairs. In the original collections the hypanthia and sepals were glabrous or with a few hairs on the base of the hypanthium.

Philadelphus texensis var. *coryanus*, in contrast, was erected to recognize a single V.L. Cory collection from Bandera Co., Texas, that had more appressed hairs on the hypanthium and sepals as in *P. ernestii* in a plant otherwise referable to *P. texensis*.

As more collections are now available, the hypanthium-sepal vestiture characters have proven to be highly variable with both glabrous and weakly to moderately sericeous-strigose hypanthia-sepals occurring in material referable to both named species, sometimes differing even in one gathering and on the same plant. In *Philadelphus ernestii*, 18 of 29 (62%) of the collections seen by me had hypanthia-sepals either weakly or moderately hairy. The others were glabrous. In *P. texensis* 12 of 22 (59%) collections had glabrous hypanthia, the remaining having some sericeous vestiture.

Regarding leaf vestiture, in *Philadelphus ernestii*, of the 34 collections observed, variable amounts of understory vestiture occurred in 7 (20%) of the collections, these from Kendall and Blanco cos., Texas. This varied from the presence of a few small crinkled hairs at the tips of some young leaves to a sometimes dense partial covering of the understory only on some leaves. Specifically, understory hairs were seen in the following collections of *P. ernestii*: Kendall Co.: Cibolo Creek, E of Cascade Caverns, *Pfeiffer 1* (SMU); same area, *Pfeiffer 2* (SMU); Spring Creek, near Boerne, *Palmer 11492* (A, TEX, but not SMU); same area, *Palmer 11595* (A, ARIZ, but not POM); Blanco Co.: Pedernales Falls State Park, *Carr 14768* (TEX); same area, Henrickson 24600-L (TEX); from the Narrows on the Rio Blanco, *Tharp 42-17* (A, GH).

In contrast the understory vestiture character that defines *Philadelphus texensis* is usually moderately stable over its range. However in one collection (Medina Co.: Bear Bluff Ranch, *Carr 19550*, SMU, TEX) the understory vestiture is very sparse and absent in some leaves. When less dense, 30-40× magnification is needed to see the underlying hairs. The vestiture is sometimes difficult to evaluate as the understory vestiture may diminish over a season.

The presence of understory vestiture on occasional leaves indicates that we are not dealing with a simple present-absent genetic-based character. Rather it seems to be a phenotype expressed, or not expressed, or partially expressed in various plants or only in portions of a plant. It is apparent that the development of the understory vestiture is a character independent of that of the longer, thicker, consistently present, overstory hairs.

The occurrence of understory hairs only on some leaves of a plant causes one to ask if it is perhaps also influenced by other factors. Regardless, the present classification of the complex follows the presence vs. absence of this understory vestiture.

There are other variable characters found in both *Philadelphus ernestii* and *P. texensis*. Petals in both can be broadly oblong-ovate, bluntly rounded or ovate and more acute at the tip, and in some *P. texensis* the petal tips can twist, further emphasizing the narrow tip. Petals in both taxa sometimes can become notched at the tips as the initially cupped petals reflex and the distal-most portion tears, leaving a distinct terminal notch — this perhaps not a genetic trait. Both taxa have occasional plants within populations with purple coloration at the filament and petal bases but this may develop only in older flowers.

All this indicates that *Philadelphus texensis* and *P. ernestii* are part of a single variable complex differing conspicuously in the presence or absence of abaxial understory hairs. But is it valid to recognize a second species for a subgroup of plants that differs only in a single, sometimes variably expressed character, especially when the two taxa involved show similar overall variation patterns? The Texas flora is full of such taxa based on a single-character differences — but that is due to the proclivities of some Texas botanists.

Interestingly the same condition occurs in related genera of Hydrangeaceae, namely *Fendlera*, where in *F. rupicola* A. Gray sensu lato, the smaller understory hairs that are more plumose with the verriculae extended into finger-like projections. The understory hairs can be present or absent, and this is often consistent in a population or over large areas, but in some regions it varies from population to population and again some plants have some leaves with sparse understory hairs, others not. In Mexican *Cercocarpus breviflorus* (Rosaceae), leaves are typically closely canescent on the abaxial surface, but in some plants, all or just some leaves are abaxially glabrous (pers. observation) with again some plants or populations having only glabrous undersurfaces. Is it wise to classify the taxa on the basis on some minor, possibly single-gene character that may be inconsistently expressed on some plants, just because it is relatively conspicuous?

Figure 1. Flowers and leaves *Philadelphus texensis* var. *ernestii* (*Henrickson 24600*) (a-b) and *Philadelphus texensis* var. *texensis* (*Henrickson 24602*) (c-d). Flowers are ± 25 mm diam.; leaves ± 20 mm long.

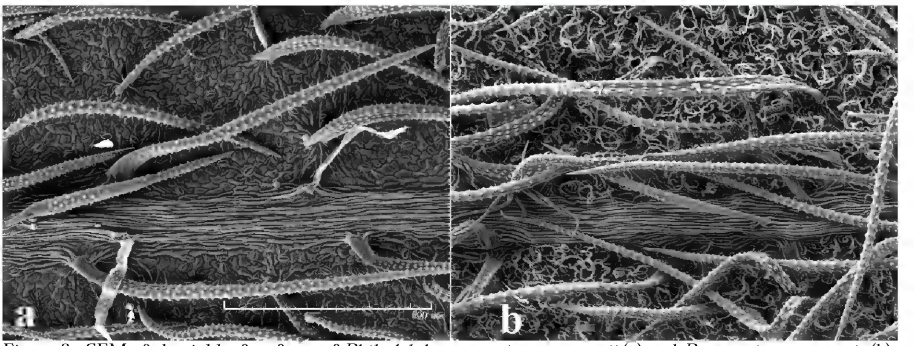

Figure 2. SEM of abaxial leaf surfaces of *Philadelphus texensis* var. *ernestii* (a) and *P. texensis* var *texensis* (b). Magnification scale = 500 µm (0.5 mm).

I consider that this pattern of variation can be used in an effective argument to combine *Philadelphus texensis* and *P. ernestii* into a single species. The presence or absence of the understory hairs does not in itself provide or even indicate any sort of isolating mechanism between two species -- it is just a more or less conspicuous character. Therefore the two taxa are treated here as a single species, and it is only with a nod to the forthcoming Flora of North America treatment of *Fendlera* by R.L. McGregor, that I recognize two, what I consider to be weak, varieties as designated below.

Philadelphus texensis S.Y. Hu var. **texensis**

Philadelphus texensis S.Y. Hu, J. Arnold Arbor. 37: 54. 1956. **LECTOTYPE (designated here): USA. Texas.** Bexar Co.: 30 mi N of San Antonio, on Upper Classeus Ranch on ledge of limestone bluff, *E.D. Schulz 115* (US!; isolectotype: fragment A).

Philadelphus texensis S.Y. Hu var. *coryanus* S.Y. Hu, J. Arnold Arbor. 37: 55. 1956. **TYPE: USA. Texas.** Bandera Co.: Vanderpool, Can Creek, *V.L. Cory 49413* (holotype: A!).

Philadelphis texensis S.Y. Hu var. **ernestii** (S.Y. Hu) Henrickson, **comb. et stat. nov.** *Philadelphus ernestii* S.Y. Hu, J. Arnold Arbor. 37: 50. 1956. **TYPE: USA. Texas.** Kendall Co.: Near Boerne, Spring Creek, *E.J. Palmer 11595* (holotype: A!; isotype: MO!).

The taxa are restricted to the Hill Country of central Texas, with outlying populations in northern Mexico (Fig. 3). *Philadelphus texensis* is known from Bexar, Kendall, Bandera, Medina, Uvalde, Real, and Edwards cos., Texas, with outlying collections from the Sierra de la Madera and Sierra San Marcos near Cuatro Cienegas in central Coahuila. *Philadelphus texensis* var. *ernestii* occurs to the northeast of var. *texensis* in Travis, Blanco, Hays, Kendall, and Bandera cos., Texas, and in the Serranias del Burro in northern Coahuila. Both taxa occur in Kendall and Bandera cos.

The occurrence of outlying populations in Coahuila of both varieties indicates that the taxa have had broader distributions in the past but have since contracted during interpluvial times, with the more southern Mexican populations surviving in higher elevations in montane canyons (1600-2400 m) and the Texas populations at higher latitudes but at lower elevations (250-600 m) in the Hill Country of central Texas. Populations of both taxa occur in similar moist limestone microhabitats along drainages, in moist canyons.

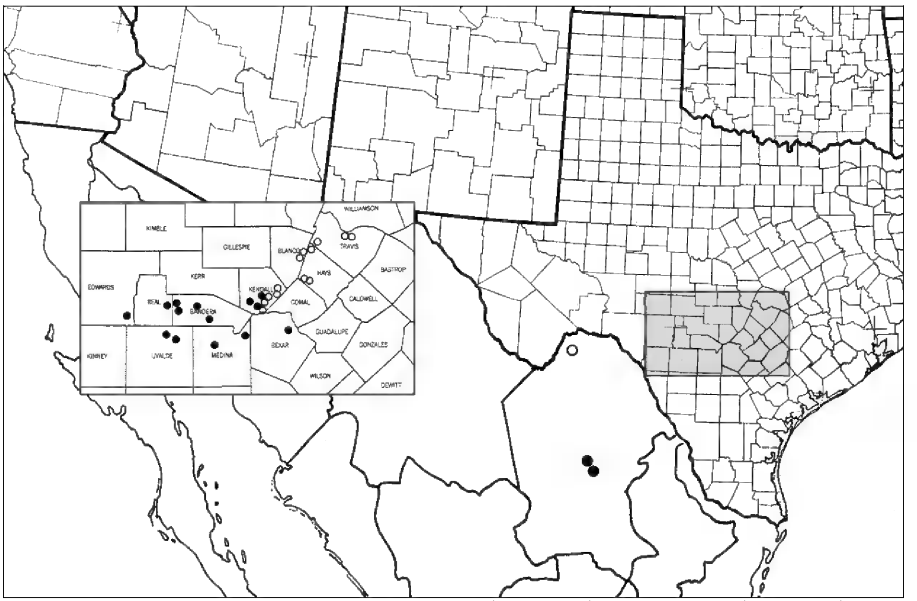

Figure 3. Distribution of *Philadelphus texensis* var. *ernestii* (open circles) and var. *texensis* (solid circles) in counties of central Texas and the state of Coahuila, Mexico. Gray area in central Texas expanded on far left.

A nomenclatural problem with *Philadelphus microphyllus* var. *stramineus* (Rydb.) Henrickson

It turns out that the recognition of the combination *Philadelphus microphyllus* var. *stramineus* (Rydb.) Henrickson (J. Bot. Res. Inst. Texas 1: 901. 2007). which is inclusive of *P. pumilus* Rydb. (N. Amer. Fl. 22: 173. 1905) and *P. pumilus* var. *ovatus* S.Y. Hu (J. Arnold Arbor. 37: 32. 1956), is superseded by a varietal autonym, *P. pumilus* var. *pumilus*, established by the creation of *P. pumilus* var. *ovatus* S.Y. Hu (McNeill et al. 2012, Art. 26.3). Article 11.6 of the Code notes that the autonym (var. *pumilus*) has priority over the name that established it (e.g., var. *ovatus*) and thus var. *pumilus* (established in 1956) has priority over var. *stramineus* (established in 2007). The correct combination at the rank of variety under *P. microphyllus* is as follows.

Philadelphus microphyllus A. Gray var. **pumilus** (Rydb.) Henrickson **comb. nov**. *Philadelphus pumilus* Rydb., N. Amer. Fl. 22: 173. 1905. *Philadelphus microphyllus* subsp. *pumilus* (Rydb.) C.L. Hitchc., Madroño 7: 49. 1943. *Philadelphus pumilus* Rydb. var. *pumilus* (autonym established by S.Y. Hu, J. Arnold Arbor. 37: 31. 1956). **TYPE: USA. California**. Riverside Co.: San Jacinto Mts., rocky places, vicinity of Tamarack Valley, 8600 ft, Jul-Aug 1901, *H.M. Hall 2500* (holotype: NY 186334; isotypes: CAS, E, MO, UC!, US, fragments A!, UC!).

Philadelphus stramineus Rydb., N. Amer. Fl. 22: 172. 1905. *Philadelphus microphyllus* subsp. *stramineus* (Rydb.) C.L. Hitchc., Madroño 7: 47. 1944. *Philadelphus microphyllus* var. *stramineus* (Rydb.) Henrickson, J. Bot. Res. Inst. Texas. 1: 901. 2007. **TYPE: USA. California.** Mono Co.: White Mountains, Aug 1888, *W.H. Shockley s.n.* (holotype: NY 00186337; isotypes: NY 00186338, UC!, fragments A!, UC!).

Philadelphus pumilus var. *ovatus* S.Y. Hu, J. Arnold Arbor. 37: 31. 1956. **TYPE: USA. California.** Riverside Co.: Tacquitz Canyon, abundant on rock crevices on desert side of the mountain, 31 Jul 1921, *E.C. Jaeger 463* (holotype: US 00096963; isotype fragment: A).

A new combination is needed for the variety of *Philadelphus microphyllus* in California.

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ASARUM HARPERI: A NEW COMBINATION FOR A *HEXASTYLIS* (ARISTOLOCHIACEAE) TAXON

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ABSTRACT

A new combination and change in status in the genus *Asarum* is proposed for *Asarum shuttleworthii* Britten & Baker f. var. *harperi* (Gaddy) Barringer. **Asarum harperi** (Gaddy) Diamond, **comb. nov.**, provides a name for this taxon at species rank.

The genus *Hexastylis* (Aristolochiaceae) is characterized by having sepals fused into a tube, extrorse stamens, and bifurcate style extensions (Blomquist 1957). It comprises about 14 taxa (Kartesz 2015), all restricted to eastern North America (Whittemore & Gaddy 1997). Recent molecular studies, howevever, have questioned the recognition of *Hexastylis* as a distinct genus, subsuming it into a broadly circumscribed *Asarum* that includes the closely related Asian genera *Heterotropa, Geotaenium,* and *Asiasarum* (Kelly 1997, 1998; Sinn et al. 2015a, 2015b). The concept of a more broad treatment of *Asarum* supports the earlier assertion of Barringer who (1993), transferred all *Hexastylis* taxa to *Asarum* that had not previously been treated as such.

One of the taxa transferred to *Asarum* by Barringer (1993) was *Hexastylis shuttleworthii* (Britten & Baker f.) Small var. *harperi* Gaddy, a narrow endemic of the southeastern USA (Kartesz 2015). In his transfer, it was maintained at varietal rank as *Asarum shuttleworthii* var. *harperi* (Gaddy) Barringer. Keener and Davenport (2015) justified the elevation of *Hexastylis shuttleworthii* Britten & Baker f. var. *harperi* to species rank as *H. harperi* (Gaddy) B.R. Keener & L.J. Davenp. However, such elevation creates a situation where the same natural entity is treated as a species in *Hexastylis* but as a variety in *Asarum*. I concur with the specific rank recommended by Keener and Davenport and propose the following new name to accommodate recognition of this taxon within *Asarum*.

Asarum harperi (Gaddy) Diamond, **comb. nov.** *Hexastylis shuttleworthii* (Britten & Baker f.) Small var. *harperi* Gaddy, Sida 12: 54. 1987. *Asarum shuttleworthii* Britten & Baker f. var. *harperi* (Gaddy) Barringer, Novon 3: 226. 1993. *Hexastylis harperi* B.R. Keener & L.J. Davenp., J. Bot. Res. Inst. Texas 9: 317. 2015.

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RANGE EXTENSION AND FIRST RECORD OF *FIMBRISTYLIS PERPUSILLA* (CYPERACEAE) FOR ALABAMA

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ABSTRACT

Harper's Fimbry (*Fimbristylis perpusilla* Harper ex Small & Britton) is a rare native annual most commonly associated with ephemeral Coastal Plain ponds. A recent collection from the Conecuh National Forest in Covington Co., Alabama, is documented and illustrated. This collection represents both a southwest range extension and a first occurrence for this species in the state of Alabama.

Harper's Fimbry (*Fimbristylis perpusilla* Harper ex Small & Britton) is a rare annual in the Sedge Family (Cyperaceae). It is native to the coastal plain from Delaware to Georgia, with upland occurrences on the Interior Low Plateaus of Kentucky and on the Cumberland Plateau of Tennessee (BONAP 2016; USDA, NRCS 2016; NatureServe 2015; Boone & Chester 2009; Kral 1971, 2002; Wofford & Jones 1988; Leonard 1987, 1981). *Fimbristylis perpusilla* has been reported from three counties each in Delaware, Georgia, and Maryland, two counties in North Carolina, and from one county each in Kentucky, Missouri, South Carolina, Tennessee, and Virginia (Missouri Natural Heritage Program 2015; NatureServe 2015).

Fimbristylis perpusilla is listed globally as a G2 species (imperiled globally because of rarity (6 - 20 occurrences) or very vulnerable to extinction throughout its range because of other factors) (NatureServe 2015). In the states of Delaware, Georgia, Kentucky, North Carolina, Tennessee, and Virginia it is listed as a S1 species (typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology making it especially vulnerable in the state) (NatureServe 2015). In Maryland and South Carolina it is listed as a S2 species (typically 6 to 20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in the state) (NatureServe 2015). Harper's Fimbry was added to the list of Missouri species and communities of conservation concern checklist in 2015 based upon an 1897 herbarium specimen from Butler County in a "dried up lake" (Missouri Natural Heritage Program 2015). It is listed as SH in Missouri (Historical: Element occurred historically in the state, with expectation that it may be rediscovered. May not have been verified in the past 20 years and suspected to be still extant).

Harper's Fimbry is a diminutive (1-8 cm) tufted annual that grows on the exposed sandy or silty bottoms of ephemeral Coastal Plain ponds and on the seasonally exposed shores of shallow ponds, reservoirs, and ditches (Kral 1971, 2002). This species was first collected by Roland Harper in Sumter Co., Georgia, on 9 October 1902 (*Harper 1729,* US) from the "muddy bottom of a dried up pine-barren pond." The species was not collected again until 1962, when discovered by Robert Kral in Seminole Co., Georgia (Godfrey & Wooten 1979). Harper's Fimbry has a very ephemeral nature, and many years or even decades may pass before conditions are favorable for its germination and growth (Harper 1904; Kral 1983; Chafin 2007).

Figure 1. *Fimbristylis perpusilla*, Conecuh National Forest, Covington Co., Alabama.

Figure 2. *Fimbristylis perpusilla* associated with *Panicum verrucosum* and the hepatic *Riccia* in a disturbed area of a Coastal Plain pond in the Conecuh National Forest, Covington Co., Alabama.

The Alabama collection of Harper's Fimbry was from the exposed but moist bottom of a large ephemeral Coastal Plain pond located in the Blue Springs Wildlife Management area of the Conecuh National Forest in Covington Co., Alabama. This represents the first report of this species from Alabama (Alabama Plant Atlas Editorial Committee 2016; Kral et al 2011; Mohr 1901) and a southwestward extension of its range. This site is approximately 167 km west of the Seminole Co., Georgia site and 440 km south of the Franklin Co., Tennessee site. The pond was almost entirely dry at the time, and the area where the specimen was collected was located at the deepest point of one "arm" of the pond complex in a disturbed area where the soil had been turned over by digging of an American Alligator. Harper's Fimbry was most common on the recently disturbed soil in full sun, and was the first species colonizing the bare soil (Fig. 2). Even very small plants rapidly flowered, and most individuals contained both flowering and fruiting heads (Fig. 1). The entire area occupied was approximately 20 m^2.

On 18 October 2015, I returned to the site and completed a more through survey of other areas of the pond bottom for additional plants. No plants of Harper's Fimbry were located in other areas of the pond without disturbed soil. Rainfall on October 26 and 27 filled the lowest areas of the pond, inundating the population.

Alabama. Covington Co.: Conecuh National Forest, bare sandy soil in full sun of alligator hole at deepest point of dry pond, 31.1°, 86.5°, 225 ft elev., assoc. species *Panicum verrucosum* Muhl., *Riccia* sp., *Eleocharis robbinsii*, *Eupatorium leptophyllum*, and *Sagittaria isoetiformis*, 6 Oct 2015, *Diamond 26886* with D. Pittman (TROY, UWAL, VDB); Conecuh National Forest, muddy disturbed bottom at deepest part of pond in full sun, around an alligator hole, 31.1°, 86.5°, 225 ft elev., 18 Oct 2015, *Diamond 26943* with P.C. Harris (TROY, UWAL, VDB).

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SCABIOSA ATROPURPUREA (DIPSACACEAE) NEW TO OKLAHOMA

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ABSTRACT

Scabiosa atropurpurea, a native of southern Europe, northern Africa, and western Asia is reported for the first time as naturalized in Oklahoma. The species is known to be naturalized in the nearby states of Arkansas, Kansas, Missouri, and Texas, as well as in California, Maine, Massachusetts, Oregon, and Washington.

Based on the following specimen collected in southern Oklahoma, we report *Scabiosa atropurpurea* L. (Dipsacaceae) as new to the spontaneous flora of that state.

Oklahoma. Bryan Co.: W side of Hwy 69/75 at the junction of South McKinney Ave and Hwy 69/75, right-of-way, near Calera, Oklahoma (33°55'19.78"N, 96°26'26.14"W), 19 Jun 2015, *Singhurst 21026* (BAYLU). Figure 1.

The *Scabiosa atropurpurea* population in Bryan County consisted of several hundred individuals in an infrequently mowed right-of-way. Associated flora included *Arnoglossum plantagineum*, *Bouteloua curtipendula*, *Carex microdonta*, *Dalea* sp., *Echinacea angustifolia*, *Fimbristylis puberula*, *Galium* sp., *Hymenopappus tenuifolius*, *Liatris* sp., *Monarda* sp., *Salvia azurea*, *Schizachyrium scoparium*, and *Stenaria nigricans*.

Scabiosa atropurpurea is known to be naturalized in the nearby states of Arkansas, Kansas, Missouri, and Texas, as well as in California, Maine, Massachusetts, Oregon, and Washington (Kartez 2015). The species is documented in Texas in Collin, Dallas, Denton, Fannin, Grayson, Hopkins, Hunt, Lamar, Tarrant, and Wise counties and presently only known from the north-central portion of the state (Diggs et al. 1999; Invasive Plant Atlas 2015). Bryan Co., Oklahoma, is adjacent to Grayson Co., Texas and therefore the Oklahoma *Scabiosa* site is an extension to the north from its Texas range.

Scabiosa atropurpurea escapes from gardens and can rapidly spread and become an aggressive invasive weed in fields, roadsides, and prairies. The plants are rosette-forming annuals or biennials with opposite, pinnately-dissected, and simple leaves. The inflorescence is a many-flowered head on a long peduncle; corollas are generally lavender, pink, or white in color. The species has a tendency to form monocultural stands and is an extraordinary ecological threat to the remaining globally rare Blackland Prairies in north-central Texas and probably adjacent Oklahoma.

Fig. 1. *Scabiosa atropurpurea* , Bryan Co., Oklahoma, 19 Jun 2015. Photo by Jason Singhurst.

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TYPIFICATION OF *SOLIDAGO CHAPMANII* (ASTERACEAE: ASTEREAE) AND A MULTIVARIATE MORPHOMETRIC COMPARISON WITH *S. DRUMMONDII, S. FISTULOSA, S. ODORA* AND *S. RUGOSA*

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ABSTRACT

A lectotype is designated for *Solidago chapmanii* (*Chapman s.n.*, GH). The species is compared with *S. drummondii, S. fistulosa, S. odora*, and *S. rugosa* using multivariate morphometric methods. *Solidago chapmanii* is found to be statistically distinct from its two most similar relatives in ser. *Odorae* and more distinct compared with the species in ser. *Venosae* and ser. *Drummondiana*.

Solidago chapmanii Torr. & A. Gray is a goldenrod species native to Peninsula Florida. It is a member of *Solidago* subsect. *Venosae* (G. Don in Loudon) Nesom and was treated as *S. odora* Ait. subsp. *chapmanii* (Torr. & Gray) Semple in the Flora of North America (Semple & Cook 2006). Small (1903) separated *S. chapmanii* (Figs. 1-2) from *S.odora* (Fig. 3) by the latter having stem pubescence in lines and leaf blades that were 6–7 times longer than wide versus the former having more evenly distributed stem pubescence and leaf blades that were 2–5 times as long as wide. Cronquist (1980) treated the species as *S. odora* var. *chapmanii* (Torr. & A. Gray) Cronq. and distinguished it from the typical var. *odora* on the basis of stem pubescence traits and leaf shape. *Solidago odora* has stems with hairs confined to decurrent lines running down from the upper leaf bases and it has leaves that are (4–)5–11 times as long as wide; leaves are strongly anise-scented when crushed. In contrast, *S. chapmanii* has stems that are evenly pubescent with sometimes a glabrous to glabrate zone below the leaf bases; leaves may lack the anise-scent when crushed or be only faintly scented.

Semple and Cook (2006) placed *Solidago odora* with subsp. *chapmanii* into ser. *Odorae* (Mackenzie) Semple of subsect. *Venosae*. Semple (2015, continuously updated) included *S. chapmanii, S. odora*, and *S. fistulosa* Ait. (Fig. 4) in ser. *Odorae*. Series *Venosae* includes *S. delicatula* Small, *S. latissimifolia*, *S. rugosa* Mill., (Fig. 5) and *S. ulmifolia* Muhl. A more detailed multivariate analysis of ser. *Venosae* is in preparation. *Solidago drummondii* Torr. & A. Gray (Fig. 6) was placed in ser. *Drummondiana* Semple of subsect. *Venosae* by Semple (2003), Semple and Cook (2006), and Semple (2015, continuously updated).

Typification

Solidago chapmanii A. Gray, Proc. Amer. Acad. Arts 16: 80. 1880. *Solidago odora* Ait. var. *chapmanii* (A. Gray) Cronq., Brittonia 29: 224. 1977. *Solidago odora* Ait. subsp. *chapmanii* (A. Gray) Semple, Sida 20: 1611. 2003. **LECTOTYPE** (designated here): **Florida**. "Pine barrens," *Chapman s.n.* (GH!, shoot on left; possible isolectotype: NY!).

The *Chapman s.n.* (GH) specimen is not annotated by A. Gray as "sp. nov." It does, however, bear Chapman's label as "Solidago odora. Our pine woods form, Fla.," which was noted by A. Gray in the protologue. The specimen also bears A. Gray's "SYN. FL. N. AMER." label and his handwritten identification on the small label as "*S. chapmanii.*" The lectotype is selected because it apparently is the collection referred to in the protologue, especially as Gray named the species for the collector.

Lectotype: Solidago chapmanii A. Gray,
Proc. Amer. Acad. 16:80. 1880. possible ILT: NY!
J.C. Semple, 15 July 2013 (semple 2013)
HARVARD UNIVERSITY HERBARIA
Possible Type Material
Proc. Amer. Acad. Arts 16: 80. 1880.
GRAY HERBARIUM
HARVARD UNIVERSITY HERBARIA
IMAGED

Figure 1. Lectotype of *Solidago chapmanii* A. Gray, *Chapman s.n.* (GH). The two shoots are apparently from the same gathering but should this prove not to be the case, the left shoot is the formal designate.

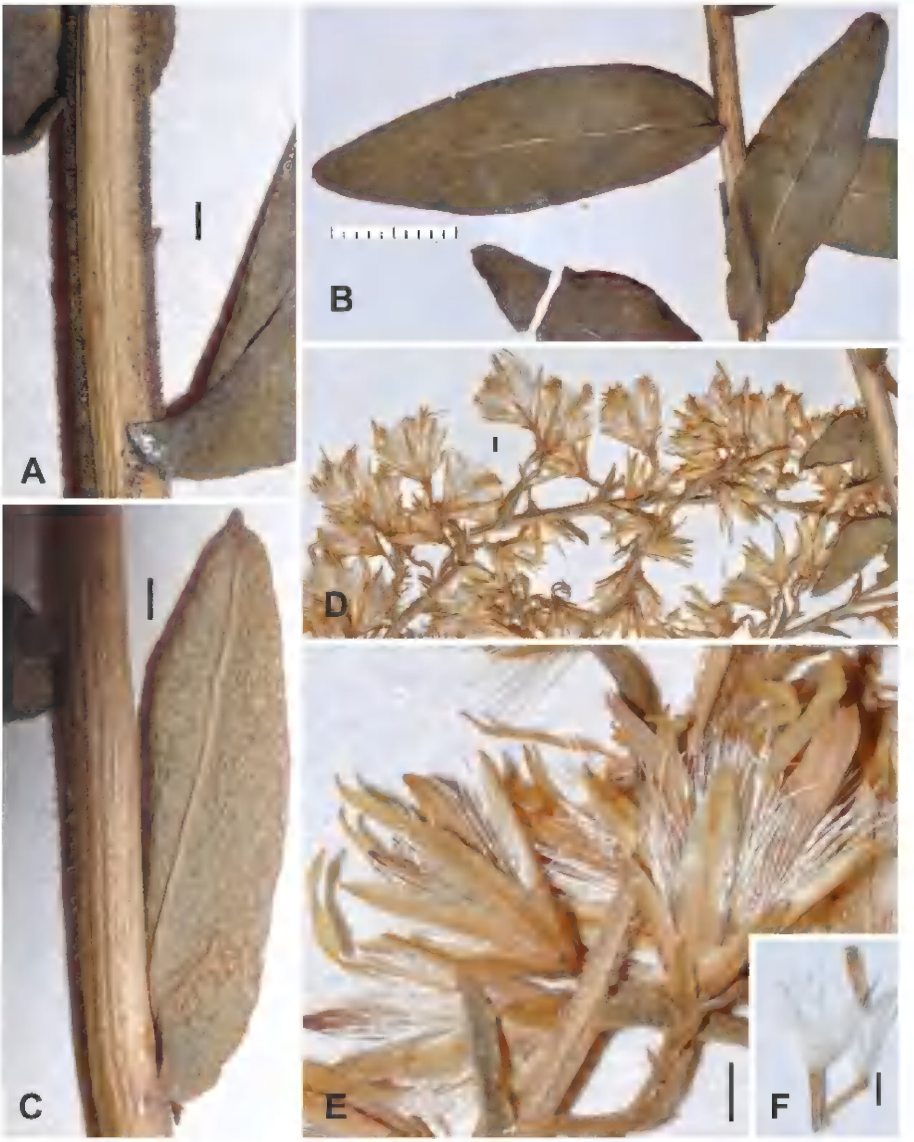

Figure 2. Details of lectotype of *Solidago chapmanii*.

Figure 3. Morphology of *Solidago odora*. **A.** Habit, South Carolina, *Semple 11669*. **B-C.** Tennessee, *Semple 11864*. **B.** Upper stem leaves. **C.** Heads and peduncular bracts.

Figure 4. *Solidago fistulosa.* **A.** Habit, Delaware. **B-C.** Florida, *Semple 11734.* **B.** Habit of large and small shoots. **C.** Upper stem leaves. **D.** Upper stem leaves, Delaware. **E.** Heads, Maryland, *Semple & Suripto 9751* (WAT); scale bar = 1 mm.

Figure 5. Morphology of *Solidago rugosa*. **A.** Habit, var. *rugosa*, Québec, *Semple & Semple 11447*. **B.** Stem leaf, var. *rugosa*, Ontario. **C.** Stem and leaves, var. *aspera*, Delaware, *Semple & Ringius 7641*. **C.** Upper stem leaves. **D.** Upper stem leaves, var. *celtidifolia*, Louisiana, *Semple & Suripto 10086* (WAT); scale bar = 1 cm. **E.** Inflorescence, var. *cronquistiana*, North Carolina, *Semple & Suripto 9666*. **F.** Stem, var. *sphagnophila*, Connecticut, *Semple & Suripto 9182*.

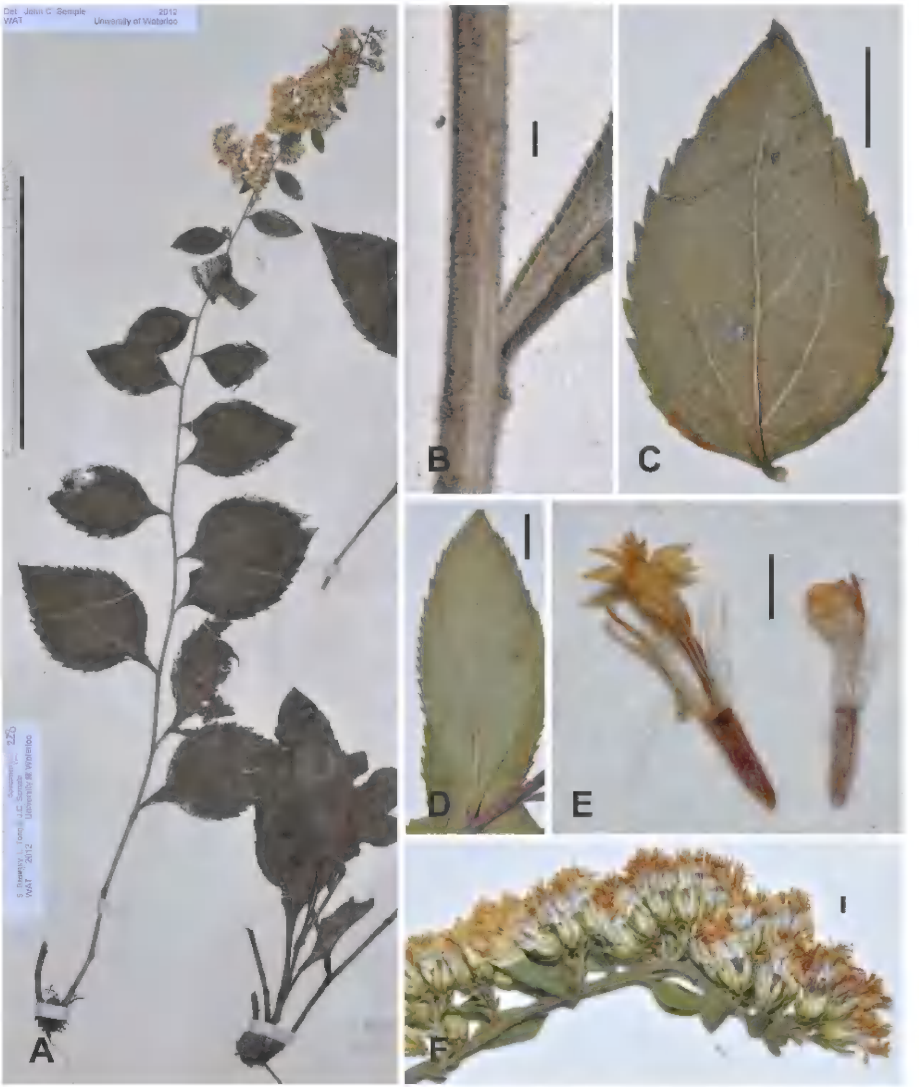

Figure 6. Morphology of Solidago drummondii. **A-B.** *Steyermark 15707* (MO). **A.** Shoot. **B.** Lower stem. **C.** Lower stem leaf, *Palmer 19447* (MO). D. Mid stem leaf, *Steyermark 26057* (MO). **E.** Disc and ray florets, *Palmer 19447* (MO). **F.** Upper portion of inflorescence, Missouri, *Rowan 1179* (MO). All collections from Missouri; scale bar = 10 cm in **A**: =1 cm in **C**, **D**; = 1 mm in **B**, **E**, **F**.

A possible duplicate of the lectotype is *Chapman s.n.* (NY ex Columbia College Herbarum!), which has a handwritten Herb. Chapman label with "Solidago odora Ait. S. fl.! Florida" on the label

and annotations "Solidago Chapmanii A. Gray K.M"{acKenzie} and S. Chapmanii, A. Gray." It is not known whether Gray saw the specimen before publishing the protologue of *Solidago chapmanii*.

Other specimens were candidates for the lectotype. Two are syntypes: **Florida**. Levy Co.: Nov 1877, *Dr. Garber s.n.* (GH-2 sheets!). Both GH specimens are marked 'Solidago chapmanii n.sp.' by A. Gray. A sheet of *Solidago chapmanii* (PH 01081724, online digital image! barcode 27138) with two shoots has a large "SYN. FL. N. AMER." label with the following in Gray's script: "This is my S. Chapmanii {(} S. odora Chapm. in part) Where did these specimens come from? Dr. Garber got it. A.G." The PH specimen may be a duplicate of the two at GH.

Multivariate analyses — materials and methods

In total, 63 specimens from MO, USF, and WAT in MT (Thiers, continuously updated) were selected for inclusion in the analysis of the three species of ser. *Odorae (18 Solidago chapmanii*, 10 *S. fistulosa* and 10 *S. odora*) plus 11 *S. drummondii* of ser. *Drummondiana* and a selected sample of 14 diploid individuals of *S. rugosa* of ser. *Venosae*. Only diploids were included because only diploids have been reported in ser. *Odorae* (Semple & Cook 2006) and comparisons with other species would be influenced by the including polyploids in samples of *Solidago rugosa*. All traits scored are listed in Table 1.

Table 1. Traits scored for the multivariate analyses of 49 specimens of four species of *Solidago* subsect. *Venosae*.

Trait	Description
MLLN	Mid leaf length
MLWD	Mid leaf width at widest point
MLSER	Number of serrations along on side of the mid leaf margin
UPLN	Upper leaf length
UPWD	Upper leaf width at widest point
UPSER	Number of serrations along on side of the upper leaf margin
INVOLHT	Height of the involucre
RAYS	Number of ray florets in a head
RAYLN	Length of the ray floret lamina
RAYWD	Width of the ray floret lamina
RACHLN	Length of the ray floret cypsela body
RPAPLN	Length of the longest ray floret pappus bristle
DISCS	Number of disc florets in a head
DCORLN	Length of the disc floret corolla including lobes
DLOBLN	Length of the disc floret corolla lobes
DACHLN	Length of the disc floret cypsela body
DPAPLN	Length of longest disc floret pappus bristle

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics, lower stem pubescence density, and leaf pubescence density were used to define a priori groups along with geographic location.

All analyses were performed using SYSTAT v.10 (SPSS 2000) following the methods of Semple et al. (2013, 2015). Three separate discriminant analyses were performed. The first was performed on five a priori species-level groups and included all 49 specimens assigned to one of the a priori groups. In the first analysis MLSER, UPLN, UPWD, UPSER, RACHLN, RPAPLN, and DACHLN were not included because these traits were not scored on *Solidago rugosa* specimens,

whose data came from a different unpublished study of ser. *Venosae*. A second analysis was performed on four a priori species groups including the 49 specimens of *S. chapmanii*, *S. drummondii*, *S. fistulosa*, and *S. odora*. A third analysis was performed on three a priori species groups of just the 38 specimens of *Solidago chapmanii*, *S. fistulosa*, and *S. odora*. The second and third analyses included all traits scored and listed in Table 1.

Five taxa analysis

In the STEPWISE discriminant analysis of five species-level a priori groups *Solidago chapmanii*, *S. drummondii*, *S. fistulosa*, *S. rugosa* and *S. odora*, the following traits listed in order of decreasing F-to-remove values were selected (F-to-remove): mid leaf width (37.57), number of ray florets (30.35), disc floret pappus length (20.01), mid leaf length (12.52), disc floret corolla length (6.69), and ray floret strap length (4.05). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicate the largest separations were between *Solidago drummondii* and *S. odora*, *S. chapmanii* and *S. fistulosa* (57.011, 54.668 and 50.980 respectively). The smallest separation was between *S. chapmanii* and *S. odora* (6.856).

Table 2. Between groups F-matrix for the five a priori group analysis (df = 8, 51).

Group	*chapmanii*	*drummondii*	*fistulosa*	*odora*	*rugosa*
chapmanii	0.000				
drummondii	46.124	0.000			
fistulosa	6.741	39.221	0.000		
odora	6.468	48.253	14.912	0.000	
rugosa	30.497	16.628	18.118	36.908	0.000

Wilks' lambda
Lambda = 0.0069 df = 8 4 58
Approx. F= 16.8343 df = 32 189 prob = 0.0000

In the Classificatory Discriminant Analysis of the five species-level a priori groups the percents of correct classification ranged from 70-100% with a mean value of 92%. The Classification matrix and Jackknife classification matrix are presented in Table 3. Results for individual a priori taxa are presented in decreasing order of percent correct. (1) 3 species had 100% a posteriori placement of specimens to their respective a priori group: 10 specimens of *Solidago odora* (9 with 91-100% probability and 1 with 70% probability), and the 14 specimens of *S. rugosa* (12 with 97-100% probability, 1 with 94% probability, and 1 with 51% probability to *S. rugosa* and 49% probability to *S. drummondii*). (2) For *S. chapmanii*, 89% correct a posteriori placement of specimens (10 with 89-100% probability and 3 with 79%, 77%, and 69% probabilities); 1 specimen was placed a posteriori in *S. odora* with 84% probability. (3) For *S. fistulosa*, 70% correct a posteriori placement of specimens (7 with 98-100% probability); 3 specimens with assigned a posteriori to *S. chapmanii* with 82%, 76%, and 63% probability. In the Jackknife classification there was only a small drop in mean correct placement to 87% correct a posteriori placement to a priori group.

Two dimensional plots of scores of CAN1 versus CAN2 and CAN1 versus CAN3 of *Solidago chapmanii, S. drummondii, S. fistulosa, S. odora,* and *S. rugosa* are presented in Figure 7. Eigen values on the first four axes were 10.483, 3.038, 0.951, and 0.131.

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Linear classification matrix

	chapmanii	*drummondii*	*fistulosa*	*odora*	*rugosa*	% correct
chapmanii	16	0	0	2	0	89%
drummondii	0	11	0	0	0	100%
fistulosa	3	0	7	0	0	70%
odora	0	0	0	10	0	100%
rugosa	0	0	0	0	0	100%
Total	19	11	7	12	14	92%

Jackknifed classification matrix

	chapmanii	*drummondii*	*fistulosa*	*odora*	*rugosa*	% correct
chapmanii	16	0	0	2	0	89%
drummondii	0	11	0	0	0	100%
fistulosa	3	0	7	0	0	70%
odora	1	0	0	9	0	90%
rugosa	1	1	0	0	12	86%
Total	21	12	7	11	12	87%

Four taxa analysis

In the STEPWISE discriminant analysis of the four species-level a priori groups *Solidago chapmanii*, *S. drummondii*, *S. fistulosa*, and *S. odora*, the following traits listed in order of decreasing F-to-remove values were selected (F-to-remove): mid leaf width (23.38), mid leaf length (22.43), number of mid leaf margin serrations (18.15), disc floret pappus length (13.29), number of ray florets (6.80), ray floret strap length (5.77), and involucre height (5.26). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 4.

Table 4. Between groups F-matrix for the four a priori group analysis (df = 7, 39).

Group	*chapmanii*	*drummondii*	*fistulosa*
drummondii	46.124	0.000	
fistulosa	6.741	39.221	0.000
odora	6.468	48.253	14.912

Wilks' lambda
Lambda = 0.0049, df = 7 3 45
Approx. F = 28.6915, df = 21 112 prob. = 0.0000

In the Classificatory Discriminant Analysis of the four species-level a priori groups the percents of correct classification ranged from 90-100% with a mean value of 98%. The Classification matrix and Jackknife classification matrix are presented in Table 5. Results for individual a priori taxa are presented in decreasing order of percent correct. (1) 3 species had 100% a posteriori placement of specimens to their respective a priori group: 18 specimens of *Solidago chapmanii* (16 with 97-100% probability, 1 with 63% probability to *S. chapmanii* and 37% to *S. odora*, and 1 with 55% to *S. chapmanii* and 45% to *S. odora*), 11 specimens of *S. drummondii* with 100% probability,

and 10 specimens of *S. odora* with 92-100% probability. (2) For *S. fistulosa*, 90% correct a posteriori placement of specimens to *S. fistulosa* (6 with 100% probability, 3 with 94%, 96%, and 97% probabilities); 1 specimen was placed a posteriori in *S. chapmanii* with 54% probability (44% probability in *S. fistulosa*).

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Linear classification matrix

	chapmanii	***drummondii***	***fistulosa***	***odora***	% correct
chapmanii	18	0	0	0	100%
drummondii	0	11	0	0	100%
fistulosa	1	0	9	0	90%
odora	0	0	0	10	100%
Total	19	11	9	10	98%

Jackknifed classification matrix

	chapmanii	***drummondii***	***fistulosa***	***odora***	**% correct**
chapmanii	16	0	0	2	89%
drummondii	0	11	0	0	100%
fistulosa	2	0	8	0	80%
odora	0	0	0	10	100%
Total	18	11	8	12	92%

Two dimensional plots of scores of CAN1 versus CAN 2 and CAN1 versus CAN3 of *Solidago chapmanii, S. drummondii, S. fistulosa*, and *S. odora* are presented in Figure 8. Eigen values on the first three axes were 27.299, 2.489, and 1.072.

Three taxa analysis

In the STEPWISE discriminant analysis with the three species level a priori groups *Solidago chapmanii, S. fistulosa*, and *S. odora*, the following traits listed in order of decreasing F-to-remove values were selected (F-to-remove): number of mid leaf serrations (52.33), mid leaf length (43.95), mid leaf width (15.98), ray floret strap length (11.24),), disc floret pappus length (10.14), and ray floret ovary length at anthesis (6.85). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 6.

Table 6. Between groups F-matrix for the three a priori group analysis (df = 6 30).

Group	***chapmanii***	***fistulosa***
fistulosa	43.188	
odora	14.808	55.261

Wilks' lambda
Lambda = 0.0234, df = 6 2 35
Approx. F= 27.6849, df = 12 60 prob = 0.0000

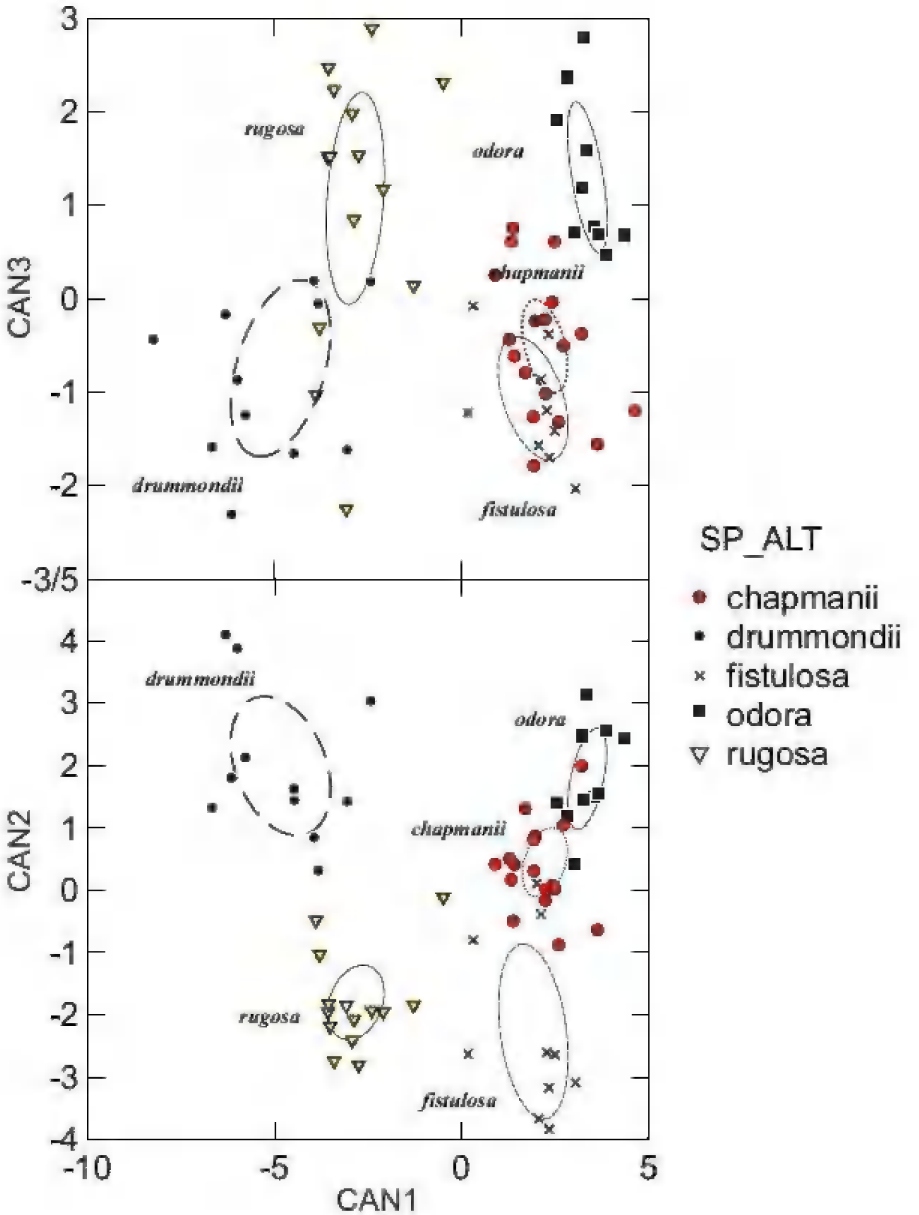

Figure 7. Two dimensional plots of canonical scores CAN1 versus CAN2 and CAN1 versus CAN3 for specimens of *Solidago chapmanii*, *S. drummondii*, *S. fistulosa*, *S. odora*, and *S. rugosa*.

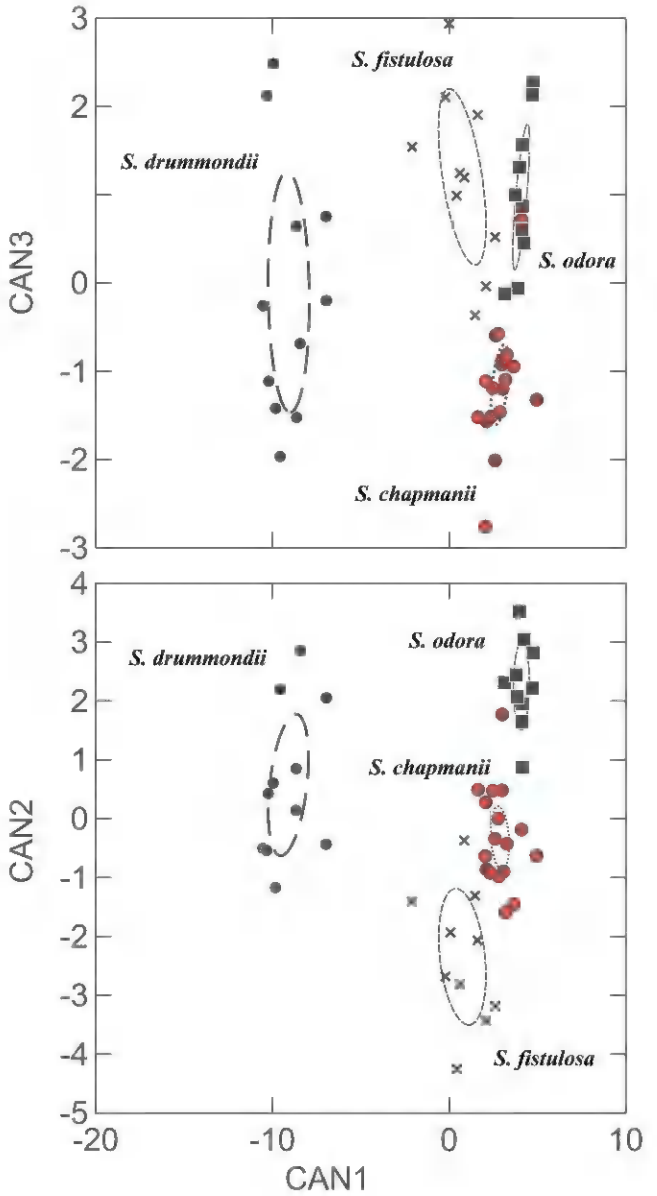

Figure 8. Two dimensional plots of canonical scores CAN1 versus CAN2 and CAN1 versus CAN3 for specimens of *Solidago chapmanii*, *S. drummondii*, *S. fistulosa*, and *S. odora*.

In the Classificatory Discriminant Analysis of the three species-level a priori groups the percents of correct classification ranged from 90-100% with a mean value of 97%. The Classification matrix and Jackknife classification matrix are presented in Table 7. Results for individual a priori taxa are presented in decreasing order of percent correct. (1) 3 species had 100% a posteriori placement of specimens to their respective a priori group: 18 specimens of *Solidago chapmanii* (16 with 97-100% probability, 1 with 63% probability to *S. chapmanii* and 37% to *S. odora*, and 1 with 55% to *S. chapmanii* and 45% to *S. odora*), 11 specimens of *S. drummondii* with 100% probability, and 10 specimens of *S. odora* with 92-100% probability. (2) For *S. fistulosa*, 90% correct a posteriori placement of specimens to *S. fistulosa* (6 with 100% probability, 3 with 94%, 96% and 97% probabilities); 1 specimen was placed a posteriori in *S. chapmanii* with 54% probability (44% probability in *S. fistulosa*).

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three priori groups.

Linear classification matrix

	chapmanii	***fistulosa***	***odora***	**% correct**
chapmanii	17	0	1	94%
fistulosa	0	10	0	100%
odora	0	0	10	100%
Total	19	9	10	97%

Jackknifed classification matrix

	chapmanii	***fistulosa***	***odora***	**% correct**
chapmanii	17	0	1	94%
fistulosa	0	10	0	100%
odora	0	0	10	100%
Total	17	10	11	97%

A two dimensional plots of scores of CAN1 versus CAN 2 of specimens of *Solidago chapmanii, S. fistulosa*, and *S. odora* are presented in Figure 9. Eigen values on the first two axes were 12.630 and 2.839.

Discussion

The results support the recognition of the following five species: *Solidago chapmanii, S. drummondii, S. fistulosa, S. odora*, and *S. rugosa*. *Solidago drummondii* is the most distinct species with its broad lower leaves with multiple prominent veins, with *Solidago rugosa* being nearly as distinct with its often strongly rugose leaves. This is demonstrated as well in the two species being separated from each other and the other three species on the first and second canonical axes in Figure 1 based on additional technical traits. This is not surprising as the two species are in ser. *Drummondii* and ser. *Venosae* of subsect. *Venosae* in Semple and Cook (2006). With a few exceptions, specimens of *S. chapmanii, S. fistulosa* and *S. odora* of ser. *Odorae* are also strongly separated in the multivariate analyses with overall high correct a posteriori placements with high probabilities in their respective species groups.

Although *Solidago chapmanii* has been treated at an infraspecific rank within *S. odora*, the two groups of specimens included in the analysis were well-supported as distinct with the misclassification of specimens occurring between *S. fistulosa* and *S. chapmanii* as well as at a low level between *S. chapmanii* and *S. odora*. Gray's 1880 original decision to treat *S. chapmanii* as a species (also regarded as distinct in a few subsequent treatments, e.g., Small 1933, Nesom 1993,

Weakley 2015) turns out to be more strongly supported than later decisions to treat the taxon as a variety or subspecies within *S. odora* (e.g., Cronquist 1977; Semple 2003; Semple & Cook 2006)). DeCronquistification of *Solidago* continues.

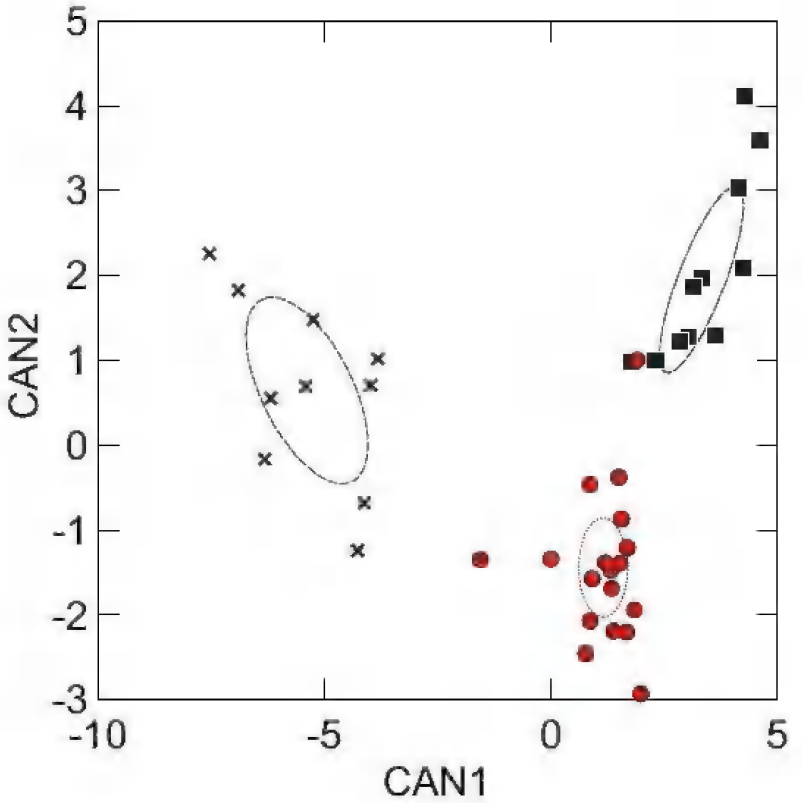

Figure 9. Two dimensional plot of canonical scores CAN1 versus CAN2 for specimens of *Solidago chapmanii*, *S. fistulosa*, and *S. odora*.

ACKNOWLEDGEMENTS

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Phytoneuron 2016-13: 1–121. Published 17 February 2016. ISSN 2153 733X

ANNOTATED CHECKLIST OF THE FLORA OF THE SIERRA VALLEY REGION OF SIERRA AND PLUMAS COUNTIES, CALIFORNIA

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ABSTRACT

The Sierra Valley region of California is unique in that three floristic zones converge in this mountain valley, the Sierra Nevada from the west, the Great Basin from the east, and to a slight degree the Cascade Range from the north. A checklist of the flora includes 93 families, 434 genera, and 1153 documented species; geographic ranges of another 125 species suggest that they also may occur in the area, for a total of 1278 species.

Sierra Valley is a large mountain valley located east of the Sierra Nevada crest. The geology of this region is complex but in a simplistic form it is a down-faulted block basin (graben) filled with volcanic ash deposits and lake sediments, similar to Lake Tahoe in geologic origin. This has resulted in an inverted "L" shaped flat basin, with an average elevation of 4900 feet over an area of approximately 208 square miles. The entire checklist area is approximately 360 square miles.

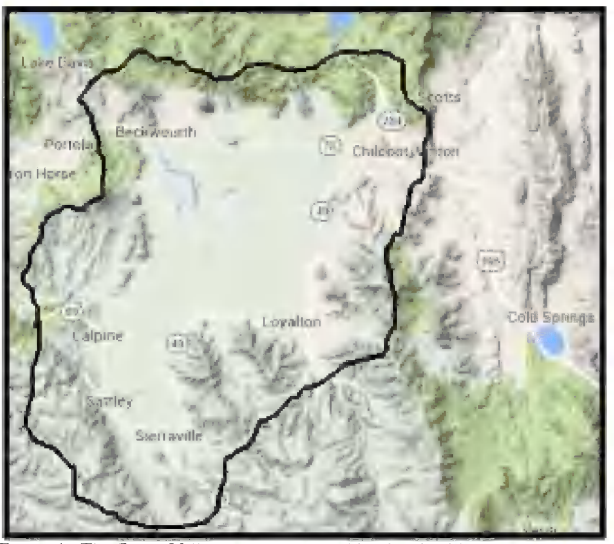

Figure 1. The Sierra Valley -- area covered by the checklist.

General notes

In 2007 I began to compile a list of plants found in the Sierra Valley region for the the 2008 Jepson Herbarium Workshop "The Flora of Sierra Valley," which my wife and I lead. This list was drawn from a multitude of resources, personal collections and communications, recent and historical literature, and a large number of internet sources.

According to *The Jepson Manual, Second Edition (TJM 2),* the California flora is comprised of 185 families, 1314 genera and 7601 species. As of December 2015, the Sierra Valley annotated checklist includes 94 families, 433 genera and 1153 recorded species; geographic ranges of an additional 125 species suggest that they also probably occur in the Sierra Valley region, for a total of 1278 species. There are 162 introduced species. Sierra Valley is home to approximately 15% of the entire California flora, an impressive number for such a small region.

Physical description and geology

Sierra Valley is a mountain valley located east of the Sierra Nevada crest (Fig. 1). As defined here, the Sierra Valley region is bounded by sightline ridges. Of the 360 square miles (approximately 230,000 acres) within the study area, the valley floor comprises approximately 208 square miles Elevations of the project region range from 4865 feet, at the outflow of the Middle Fork of the Feather River near Portola, to 8058 feet at the summit of Mt. Ina Coolbrith near Loyalton.

In the Sierra Valley region, 43% (155 square miles) of the land is in Sierra County and 57% in Plumas County (207 square miles). The majority of the land on the valley floor, in both Sierra County and Plumas County, is in private ownership and in agricultural production.

The geology of this region is complex but in simplistic form it is a down-faulted block basin (graben) that is filled with volcanic ash deposits and lake sediments and is similar to Lake Tahoe in geologic origin. The depth of these ash deposits and lake sediments in some areas is well over 1000 feet, as determined by geothermal drilling done in the 1970's and 80's.

Within the region there are three main geologic features. The main one is the valley fill, consisting primarily of volcanic ash capped with recent erosional material that makes up approximately 60% of the Sierra Valley region. To the southwest, in the Calpine, Sattley, and Yuba Pass areas, and also in the northeast area of the valley in the Beckwourth Pass and Chilcoot areas are the granitic zones. Finally, the rest of the surrounding area is covered with pyroclastic flows and ash deposits. There are also several remnant volcanic plugs within the valley, with the most notable being Sugarloaf near Beckwourth.

A common misconception is that Sierra Valley is a Sierra Nevada range feature, but from a geologist's point of view it is not. Both Sierra Valley and Lake Tahoe lay east of the crest of the Sierras, not unlike Owens Valley. As a consequence, Sierra Valley and Lake Tahoe are both in the Basin and Range Province but not the Great Basin proper. The eastern escarpment of the Sierra Nevada range turns to the northwest in Sierra Valley and continues into the area of Quincy, California.

Climate

The Sierra Valley region is a land of climatic extremes. Unlike the west slope of the Sierra Nevada Range, the valley climate is Continental, not Mediterranean, and is therefore subject to greater extremes than those normally associated with typical California weather.

The average precipitation in Sierra Valley ranges from 15 to 20 inches per year, with the major part of that being snowfall. The amounts of precipitation drop sharply moving from the west side of the valley to the east side. Temperatures of less than -40 F have been recorded, with some summer temperatures exceeding 100 F. Temperature variations of 40 F to 50 F during a day, from the high 30's to the low 90's, are common in the summer and I have personally seen the temperature in one day go from a low of 34 degrees to a high of 104 degrees in Jul. Summer rainfall is normally confined to thunderstorms and these are mainly on the north end and the east side of the valley.

Vegetation

SAGEBRUSH SCRUB. This is the main vegetation type throughout the Sierra valley region. This association is found mainly on the valley floor but moves up the slopes in the north and eastern portion of the valley.

PONDEROSA/JEFFREY PINE AND FIR FORESTS. These are found primarily on the edge of the valley from the Loyalton to the Calpine area, typically on the steeper slopes with some extension onto the valley floor.

OAK WOODLANDS. Black oak woodlands are found in scattered locations on the edge of the valley, primarily on the northern edges of the valley.

JUNIPER WOODLANDS. The primary areas of juniper woodlands are along the southeastern flank of the valley along Hwy 49 between Sierraville and Loyalton. These are typically narrow bands and are usually found between the valley floor and the Jeffrey pine zone.

MARSHLANDS. The marshlands are one of the features that add to the beauty and diversity of the valley. Found primarily through the center of the valley from south of the "Steel Bridge" on Marble Lane to the Ramelli Ranch near Beckwourth. On the early maps of the region there was an area east of Calpine known as "The Tules;" extensive channelization in the late 1800's and early 1900's has converted much of this to irrigated pasture.

VERNAL POOLS. There are a number of vernal pool located in the Sierra Valley region, primarily on the western edge of the valley floor, with the preeminent pool located near Calpine. Unfortunately this site is now degraded due to management practices. All of the vernal pool sites are located on private property.

Sites accessible to the general public

Since the majority of the Sierra Valley region is under private ownership, at least on the valley floor, areas open to the public are given here.

Ramelli Ranch: Located southwest of Beckwourth at the intersection of Hwy 70 and County Road A-23. This location offers both riparian and sagebrush associations to stroll through. The property is managed by the United States Forest Service and is open to the public. Some of the land is leased for grazing, so please respect the rights of the lease holder. The area west of the County Road A-23 bridge and to the south of the Feather River has an astounding variety of riparian and sagebrush flora, including *Ivesia aperta* var. *aperta*.

Maddalena Ranch: Located to the southeast of Beckwourth, 1.75 mi south of the intersection of Hwy 70 and County Road A-24. This is a property owned by the Feather River Land Trust and the area is open to the general public. The land trust has set up wildlife viewing areas and short trails where you can get your feet wet in the marshlands. Parts of this land are also leased for grazing, so please respect the fences and leave all gates as you found them.

Roadsides: All the roads in the area have right of ways that typically extend to the fence lines. The most traveled road in the area is Marble Lane which extends east from County Road A-23 to County Road A-24. This is where the "Steel Bridge" is located. Roadside viewing of the flora is amazing and the birding is a bonus. John Thomas Howell best described the roadside flora of Sierra Valley in his wonderful "*Five Days to Reno, A Botanical Motorlogue*" with this statement; "I meandered through the Feather River country and became almost immobile on the flower-spattered flats of Sierra Valley." It was on this trip that he collected what he described as "A New Sierran *Pontentilla*" that is now known as *Ivesia aperta* var. *aperta*.

Antelope Valley: Located 3.5 mi west of Loyalton on Hwy 49, Antelope Valley is south of Hwy 49 along the Antelope Valley Road (County Road 855). Approximately 2 mi from Hwy 49 is a cattle guard and once past this point you are off private property and on lands managed by the California Department of Fish & Game.

US Forest Service maps of the Tahoe and Plumas National Forests are excellent guidelines to the land ownership of the region.

Special status plants as defined by the California Native Plant Society

In 1968 the California Native Plant Society (CNPS) created the "Rare Plant Program," which resulted in the *Inventory of Rare and Endangered Plants of California*. Recently the CNPS Rare Plant Program and Rare Plant Committee developed a newer system, the California Rare Plant Ranks (CRPR). The list below reflects the rare plants found in the Sierra Valley region included in the "Inventory" and their ranking.

CRPR 1B: Plants Rare, Threatened, or Endangered in California and elsewhere

Astragalus lemmonii
Astragalus lentiformis
Astragalus pulsiferae var. *pulsiferae*
Epilobium oreganum
Ivesia aperta var. *aperta*
Ivesia sericoleuca
Ivesia webberi
Juncus luciensis
Oreostemma elatum
Polygonum polygaloides subsp. *esotericum*
Pyrrocoma lucida

CRPR 2B: Plants Rare, Threatened, or Endangered in California, but more common elsewhere

Atriplex argenta var. *hillmanii*
Brasenia schreberi
Erigeron eatonii var. *nevadincola*
Hymenoxys lemmonii
Ivesia baileyi var. *baileyi*
Kobresia myosuroides
Potamogeton epihydrus
Stanleya viridiflora
Thelypodium milleflorum
Viola purpurea subsp. *aurea*

CRPR 4: Plants of limited distribution - A watch list

Epilobium howellii
Eriastrum sparsiflorum
Eriogonum baileyi var. *praebens*
Eriophorum gracile
Juncus hemiendytus var. *abjectus*
Lomatium canbyi
Mimulus pygmaeus
Senecio hydrophiloides
Subularia aquatica subsp. *americana*
Trifolium andersonii var. *andersonii*
Trifolium lemmonii

The checklist

Introduced species are denoted by the use of the "*Helvetica*" typeface. Species not yet documented but expected to be found in the Sierra Valley are indicated as such ("to be looked for").

LYCOPHYTES

ISOETACEAE Quillwort Family

ISOETES Quillwort

Isoetes bolanderi Engelm. BOLANDER'S QUILLWORT
Ponds and persistent waters. Spores late summer. Calpine, T21N R14E S16.

Isoetes howellii Engelm. HOWELL'S QUILLWORT
Infrequent. Margins of vernal pools and small lakes. Spores late spring. Marble Lane, T22N R13E S13.

Isoetes nuttallii Engelm. NUTTALL'S QUILLWORT
Vernally wet areas. Spores late spring. Calpine, T21N R13E S24.

FERNS

DENNSTAEDTIACEAE Bracken Family

PTERIDIUM Bracken or Brake

Pteridium aquilinum (L.) Kuhn var. ***pubescens*** Underw. WESTERN BRACKEN FERN
Common, open forest. Yuba Pass, T20N R13E S11.

DRYOPTERIDACEAE Wood Fern Family

DRYOPTERIS Wood Fern

Dryopteris arguta (Kaulf.) Maxon WOOD FERN
Clefts of rocks and open wooded slopes. One record for Sierra Valley (UC 433179, unknown collector, Sierra Valley, 1890, From the herbarium of J.G. Lemmon). This could be either Sierra or Plumas Co.

EQUISETACEAE Horsetail Family

EQUISETUM Horsetail, Scouring-Rush

Equisetum arvense L. COMMON HORSETAIL
Scattered in wet shaded areas. Sattley, T21N R14E S31; Sugarloaf, T23N R15E S17.

Equisetum* x *ferrissi Clute FERRIS' HORSETAIL
Uncommon, moist sandy areas. Beckwourth, T23N R14E S26.

Equisetum laevigatum A. Braun SMOOTH SCOURING-RUSH
Fairly frequent in colonies. Sattley, T21N R14E S33; Beckwourth Sattley Road, T21N R14E S21; Sugarloaf, T23N R15E S17.

MARSILEACEAE Water-Clover Family

MARSILEA Water-Clover

Marsilea oligospora Goodd. NELSON'S WATER CLOVER
Edges of ponds and deeper vernal pools. Calpine, T21N R14E S16.

Marsilea vestita Hook. & Grev. subsp. ***vestita*** HAIRY WATER CLOVER
Fairly common. Edges of ponds, rivers and ditches. Calpine, T21N R14E S16; Knuthson Meadow, T21N R14E S5; Hwy 49 (between Sierraville and Loyalton), T21N R14E S24.

PILULARIA Pillwort

Pilularia americana A. Braun AMERICAN PILLWORT
Infrequent. Vernally wet pools and often overlooked. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

POLYPODIACEAE Polypody Family

POLYPODIUM Polypody

Polypodium californicum Kaulf. CALIFORNIA POLYPODY
There are several herbarium sheets attributed to J.G. Lemmon for this taxon in Sierra Valley, though one is annotated to say the fronds are typical of the coastal form. Unlikely that this taxon was collected in the Sierra Valley region.

PTERIDACEAE Brake Family

ASPIDOTIS Lace Fern

Aspidotis densa (Brack.) Lellinger DENSE LACE FERN
Scattered, rocky outcroppings. Beckwourth Sattley Road (near Westside Cemetery), T22N R14E S23.

CRYPTOGRAMMA Rock-Brake

Cryptogramma acrostichoides R. Br. AMERICAN PARSLEY FERN
Moist to dry rocky slopes and crevices. Several records for Sierra Valley, but none pinpoint the locality. To be looked for in the Yuba Pass area as this taxon has been collected just to the west.

MYRIOPTERIS Lip Fern

Myriopteris gracillima (D.C. Eat.) J. Sm. LACE LIP FERN
Common, rocky areas. Mapes Canyon, T23N R14E S11; Yuba Pass, T20N R13E S11; Antelope Valley, T21N R15E S28; Correco Canyon (S of Vinton), T22N R16E S27; Sierraville, T20N R14E S13; Sugarloaf, T23N R15E S17 [= *Cheilanthes gracillima*].

Myriopteris intertexta (Maxon) Grusz & Windham COASTAL LIP FERN
Crevices and bases of rocky outcrops. One historical record for the Sierra Valley region (SD9552, J.G. Lemmon 1876, Sierra Valley) [= *Cheilanthes intertexta*].

PELLAEA Cliff-Brake

Pellaea brachyptera (T. Moore) Baker SIERRA CLIFF BRAKE
Widely scattered, dry rocky ledges. Two historic collections for Sierra Valley (SD9635, R. M. Austin in 1877, Plumas Co. & SD134590, J.G. Lemmon, May 1880, Plumas Co.).

Pellaea breweri D.C. Eat. BREWER'S CLIFF BRAKE
Open rocky slopes or ledges. Dotta Canyon, T24N R15E S31 (this is just outside of the Sierra Valley project area).

Pellaea bridgesii Hook. BRIDGE'S CLIFF BRAKE
Generally N facing granitic rock faces. One historic collection for Sierra Valley (SD19373, Lemmon, s.n., 1876).

Pellaea mucronata (D.C. Eat.) D.C. Eat. BIRD'S FOOT FERN
Dry rocky slope or basalt formations. One historic record for Sierra Valley (SD9665, J.G. Lemmon, s.n., 1876, Plumas Co).

WOODSIACEAE Cliff Fern Family

ATHYRIUM Lady Fern

Athyrium filix-femina (L.) Roth var. ***cyclosorum*** Rupr. WESTERN LADY FERN
One historical collection for the Sierra Valley region (SBBG45294, J.G. Lemmon, s.n., no date, Sierra Valley).

CYSTOPTERIS Bladder Fern

Cystopteris fragilis (L.) Bernh. BRITTLE FERN
Shady stream sides and moist rocky crevices. Beckwourth Sattley Road, T22N R14E S23; Frenchman Lake Road, T23N R16E S4; Sugarloaf, T23N R15E S17.

WOODSIA Cliff Fern

Woodsia oregana D.C. Eat. WESTERN CLIFF FERN
Limited, above 4500 ft., dry rocky areas and cliffs. Table Rock (NE of Beckwourth), T23N R15E S7.

Woodsia scopulina D.C. Eat. MOUNTAIN CLIFF FERN
Infrequent, rocky cliffs. Frenchman Lake Road, T23N R16E S3.

GYMNOSPERMS

CUPRESSACEAE Cypress Family

CALOCEDRUS Incense Cedar

Calocedrus decurrens (Torr.) Florin INCENSE-CEDAR
Common on the western slopes and sometimes to the valley floor. There is one tree of this species that measures 5.88" DBH within the project area. Calpine, T21N R14E S16.

JUNIPERUS Juniper

Juniperus grandis R.P. Adams WESTERN JUNIPER
Common on the eastern edges of the valley; dry rocky slopes. Loyalton, T21N R16E S17 [= *Juniperus occidentalis* var. *australis*].

Juniperus occidentalis Hook. WESTERN JUNIPER
Common on the eastern edges of the valley; dry rocky slopes. Loyalton, T21N R15E S13.

EPHEDRACEAE Ephedra Family

EPHEDRA

Ephedra viridis Coville MORMON TEA
Infrequent, sandy to rocky slopes. Beckwourth Pass, T23N R16E S35.

PINACEAE Pine Family

ABIES Fir

Abies concolor (Gordon & Glend.) Hildebr. WHITE FIR
Common on the slopes surrounding the valley. Calpine, T21N R14E S16.

Abies magnifica A. Murray bis var. ***magnifica*** RED FIR
Frequent, mountain slopes and ridges. Yuba Pass, T20N R13E S11.

PINUS Pine

Pinus contorta Loudon var. ***murrayana*** (Grev. & Balf.) Critchf. LODGEPOLE PINE
Occasional on the valley floor and meadows on the edges of the valley. Calpine, T21N R14E S16.

Pinus jeffreyi Grev. & Balf. JEFFREY PINE.
Common on valley floor and slopes. Calpine, T21N R14E S16.

Pinus lambertiana Douglas SUGAR PINE
Scattered on the southwestern slopes of the valley. There is one tree of this species in the project area that measures 7.08' DBH. Hwy 49 (W of Sattley), T21N R14E S31.

Pinus monophylla Torr. & Frém. SINGLELEAF PINYON PINE
One lone stand near the head of Doe Canyon, SE of Loyalton (JPS46831, Stephen N. Wyckoff, 12-Sep-1920, Loyalton). Loyalton, T21N R16E S21.

Pinus monticola D. Don WESTERN WHITE PINE
Infrequent on slopes and ridges. Coburn Lake, T20N R14E S20.

Pinus ponderosa Lawson & C. Lawson var. ***ponderosa*** PONDEROSA PINE
Scattered on valley floor, slopes and ridges. There is one tree of this species in the project area that is 5.62' DBH. Calpine, T21N R14E S16.

Pinus ponderosa Lawson & C. Lawson var. ***washoensis*** (H. Mason & Stockw.) J.R. Haller & Vivrette WASHOE PINE
Reported for the E side of Sierra Valley near Loyalton.

PSEUDOTSUGA

Pseudotsuga menziesii (Mirb.) Franco var. ***menziesii*** DOUGLAS FIR
Infrequent on slopes on W side of valley. There is one tree of this species in the project area that is 7.00' DBH. Calpine, T21N R14E S16 & 18.

TSUGA Hemlock

Tsuga mertensiana (Bong.) Carriére MOUNTAIN HEMLOCK
Local (above 6000 ft.), N slopes where the snow stays the longest. Coburn Lake, T20N R14E S29.

NYMPHAEALES

CABOMBACEAE Watershield Family

BRASENIA

Brasenia schreberi J.F. Gmel. WATER-SHIELD
Uncommon, shallow ponds. CRPR 2B. Jun-Aug. Hwy 49 (between Sierraville and Sattley), T20N R14E S11.

NYMPHAEACEAE Water-Lily Family

NUPHAR

Nuphar polysepala Engelm. POND LILY
Scattered, sluggish water and ponds. Apr-Aug. Marble Lane, T22N R15E S18; Beckwourth, T23N R14E S27.

MAGNOLIIDS

ARISTOLOCHIACEAE Pipevine Family

ASARUM Wild-Ginger

Asarum lemmonii S. Wats. LEMMON'S GINGER
Syntype, J.G. Lemmon, #1139, 1875, Sierra County (GH32020). It is more likely the syntype is from the Butterfly Valley area of Plumas Co., even though Lemmon described collecting this specimen at his brother's ranch in Sierra Valley.

CERATOPHYLLALES

CERATOPHYLLACEAE Hornwort Family

CERATOPHYLLUM

Ceratophyllum demersum L. SUBMERGED HORNWORT
Infrequent, ponds and slow moving streams. Jun-Aug. Ramelli Ranch, T23N R14E S27.

EUDICOTS

ADOXACEAE

SAMBUCUS Elderberry

Sambucus nigra L. subsp. ***caerulea*** (Raf.) Bolli BLUE ELDERBERRY
Fairly frequent, open slopes and burn areas. Jun-Sep. Beckwourth Sattley Road, T21N R14E S3 [*S. mexicana* misappl.].

Sambucus racemosa L. var. ***melanocarpa*** (A. Gray) McMinn BLACK ELDERBERRY
Uncommon, streams and meadow margins. Jun-Jul. Yuba Pass, T20N R13E S14 [= *S. m.*].

Sambucus racemosa L. var. ***racemosa*** RED ELDERBERRY
Scattered, moist or rocky slopes. Jun-Aug. To be looked for in the Yuba Pass area and other locations at higher altitudes [= *S. r.* var. *microbothrys*].

AMARANTHACEAE Amaranth Family

AMARANTHUS Amaranth

Amaranthus albus L. WHITE TUMBLEWEED
Scattered in disturbed areas. Jun-Oct. Dyson Lane, T22N R15E S21; Vinton, T23N R16E S31; Ramelli Ranch, T23N R14E S28.

Amaranthus blitoides S. Wats. MAT AMARANTH
Sandy and waste areas. Jul-Nov. Dyson Lane, T22N R15E S21; Hwy 49 (S of Vinton), T22N R16E S4; Sugarloaf, T23N R15E S17.

Amaranthus californicus (Moq.) S. Wats. CALIFORNIA AMARANTH
On moist flats, sand bars and disturbed areas. Jul-Oct. Ramelli Ranch, T23N R14E S27.

Amaranthus powellii S. Wats. POWELL'S AMARANTH
Disturbed waste places and dry pond margins. Jun-Oct. Hwy 49 (S of Vinton), T22N R16E S4; Calpine, T21N R14E S16.

APIACEAE Carrot Family

ANGELICA Angelica

Angelica breweri A. Gray BREWER'S ANGELICA
Occasional, open wooded slopes. Jun-Aug. Calpine, T21N R14E S18; Yuba Pass, T20N R13E S24.

APIUM Celery

Apium graveolens L. CELERY
Naturalizing along the road edge. May-Jul. Sierraville, T20N R14E S13.

BERULA Water-Parsnip

Berula erecta (Huds.) Coville CUT LEAF WATER PARSNIP
Marshy areas and springs. Jul-Oct. One historical record for Sierra Valley (JEPS16044, J.G. Lemmon, 1889, Sierra Co.).

CICUTA Water Hemlock

Cicuta douglasii (DC.) J.M. Coult. & Rose WESTERN WATER HEMLOCK
Frequent in roadside ditches and sluggish water. Jun-Sep. Marble Lane, T22N R15E S18; Ramelli Ranch, T213N R14E S27; Hwy 49 (between Sierraville and Sattley), T20N R14E S10.

CONIUM Poison Hemlock

Conium maculatum L. POISON-HEMLOCK
Common on road edges and waste places. May-Jul. Hwy 49 (between Sattley and Sierraville), T20N R14E S13.

CYMOPTERUS

Cymopterus terebinthinus (Hook.)Torr. & A. Gray var. ***californicus*** (J.M. Coult. & Rose) Jeps. CALIFORNIA SPRING PARSLEY
Rocky areas. May-Jun. To be looked for in the Yuba Pass and Lincoln Ridge areas. Found to the S and W of the project area.

DAUCUS Carrot

Daucus carota L. QUEEN ANNE'S LACE
Waif. One visual sighting along the Beckwourth Sattley Road approximately 1 mi S of the Plumas-Sierra County line. T21N R14E S4. Jul-Aug 2007.

ERYNGIUM Coyote-Thistle

Eryngium alismifolium Greene ALISMA-LEAVED BUTTON CELERY
Infrequent, drying swales and roadside ditches. Jun-Aug. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Ramelli Ranch, T22N R14E S27.

HERACLEUM

Heracleum maximum W. Bartram COW-PARSNIP
Scattered in moist shaded areas. May-Jul. Yuba Pass, T20N R13E S11.

LIGUSTICUM Lovage

Ligusticum grayi J.M. Coult. & Rose GRAY'S LOVAGE
Higher elevations, mostly red fir forest. Jul-Aug. Yuba Pass, T20N R13E S11.

LOMATIUM

Lomatium canbyi (J.M. Coult. & Rose) J.M. Coult. & Rose CANBY'S LOMATIUM, CHUCKLUSA
Sagebrush steppe. CRPR 4. Apr-May. Found just to the N in Red Clover Valley. To be looked for in the hills on the N end of Sierra Valley.

Lomatium dissectum (Nutt.) Mathias & Constance var. ***multifidum*** (Nutt.) Mathias & Constance FERN LEAF LOMATIUM
Wooded or brushy slopes. May-Jul. Ramelli Ranch, T23N R14E S27; Sattley, T20N R14E S4; Beckwourth Sattley Road, T22N R14E S23.

Lomatium macrocarpum (Torr. & A. Gray) J.M. Coult. & Rose LARGE-FRUITED LOMATIUM
Frequent, dry slopes and flats. May-Jul. The Buttes, T23N R15E S28; Antelope Valley, T21N R15E S33; Sattley, T20N R14E S10; Sugarloaf, T23N R15E S17.

Lomatium nevadense (S. Wats.) J.M. Coult. & Rose var. ***nevadense*** NEVADA LOMATIUM
Frequent, sagebrush scrub, rocky to sandy dry slopes. Apr-Jul. Frenchman Lake Road, T23N R15E S25; Calpine, T21N R14E S16.

Lomatium nudicaule (Pursh) J.M. Coult. & Rose PESTLE STEM LOMATIUM
Frequent, clay flats and slopes. Apr-Jun. Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Lomatium piperi J.M. Coult. & Rose PIPER'S LOMATIUM
Frequent, clay soils. Mar-May. Often missed because of its small size and early bloom period. Calpine, T21N R14E S16.

Lomatium plummerae (J.M. Coult. & Rose) J.M. Coult. & Rose PLUMAS LOMATIUM
Fairly frequent on open slopes and meadow edges, often with sagebrush. Apr-Jul. Beckwourth Pass, T22N R17E S6; Beckwourth Sattley Road (N of Sattley), T21N R14E S28; Antelope Valley, T21N R15E S28 & S33.

OROGENIA

Orogenia fusiformis S. Wats. CALIFORNIA OROGENIA
Clay flats and wooded areas. Apr-Jun. Often overlooked or confused for *Lomatium piperi*. Calpine, T21N R14E S16.

OSMORHIZA Sweet Cicely

Osmorhiza berteroi DC. MOUNTAIN SWEET CICELY
Common in moist woods and forests. Apr-Jul. Yuba Pass, T20N R13E S11 [*O. chilensis*].

Osmorhiza brachypoda Torr. CALIFORNIA SWEET CICELY
Conifer forests. May-Jun. To be looked for as this taxon has been reported from just W of the Yuba Pass area.

Osmorhiza depauperata Phil. DEPAUPERATE SWEET CICELY
Aspen and conifer woodlands. Apr-Jun. One historical record for the Sierra Valley region (JEPS15949, J.G. Lemmon, circa 1883, Sierra Valley).

Osmorhiza occidentalis (Nutt.) Torr. WESTERN SWEET CICELY
Moist woods and forests. May-Jul. Yuba Pass, T20N R13E S11.

OXYPOLIS

Oxypolis occidentalis J.M. Coult. & Rose COW-BANE
Shallow water or wet places. Jul-Sep. Sattley, T20N R14E S9.

PERIDERIDIA Yampah

Perideridia bolanderi (A. Gray) A. Nels. & J.F. Macbr. subsp. ***bolanderi*** BOLANDER'S YAMPAH
Frequent, meadows and surrounding slopes. Jun-Aug. Hwy 89 (N of Sattley), T21N R14E S32; Beckwourth Sattley Road, T22N R14E S18; Sugarloaf, T23N R15E S17.

Perideridia howellii (J.M. Coult. & Rose) Mathias HOWELL'S YAMPAH
Uncommon, wet meadows and spring areas. Jul-Aug. Sattley, T20N R14E S9; Calpine, T21N R14E S19; Sierraville, T20N R15E S16.

Perideridia lemmonii (J.M. Coult. & Rose) T.I. Chuang & Constance LEMMON'S YAMPAH
Common, moist to drying clay soils. Jul-Aug. Beckwourth Sattley Road, T21N R14E S9; Sattley, T20N R14E S10.

Perideridia parishii (J.M. Coult. & Rose) A. Nels. & J.F. Macbr. subsp. ***latifolia*** (A. Gray) T.I. Chuang & Constance PARISH'S YAMPAH
Frequent, moist meadows and open moist flats. Jul-Aug. Ramelli Ranch, T23N R14E S27.

SANICULA Snakeroot

Sanicula bipinnatifida Hook. PURPLE SANICLE
Open conifer forest. May-Jun. Calpine (Mtn. Quail Road), T21N R14E S20.

Sanicula graveolens DC. SIERRA SANICLE
Frequent, open forest floors. Apr-Jun. Calpine, T21N R14E S16.

Sanicula tuberosa Torr. TUBEROUS SANICLE
Frequent, open forest floors and slopes. Mar-Jul. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

SIUM Water Parsnip

Sium suave Walter WATER PARSNIP
Uncommon, marshes & wetlands. Jul-Aug. Marble Lane, T22N R14E S13.

SPHENOSCIADIUM

Sphenosciadium capitellatum A. Gray RANGER BUTTONS
Uncommon. Meadows and swampy places near streams and seeps. Jul-Aug. Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11.

APOCYNACEAE Dogbane Family

APOCYNUM Dogbane

Apocynum androsaemifolium L. SPREADING DOGBANE
Common on open forest floors. Jun-Aug. Calpine, T21N R14E S20; Hwy 49 (W of Sattley), T21N R14E S31.

Apocynum cannabinum L. INDIAN HEMP
Uncommon, disturbed areas. Jul-Aug. Calpine, T21N R14E S17.

ASCLEPIAS Milkweed

Asclepias cordifolia (Benth.) Jeps. PURPLE MILKWEED
Scattered in open wooded and rocky areas. Apr-Jul. Sattley, T20N R14E S4.

Asclepias eriocarpa Benth. KOTOLO MILKWEED
Uncommon, dry barren areas. Jun-Jul. Marble Lane, T22N R14E S13.

Asclepias fascicularis Decne. NARROW-LEAVED MILKWEED
Uncommon, rocky slopes and dry rocky stream beds. Jun-Sep. Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S17.

Asclepias speciosa Torr. SHOWY MILKWEED
Open fields, slopes and disturbed areas. May-Jul. Hwy 49 (W of Sattley), T20N R13E S30; Sierraville, T20N R14E S13 & T20N R15E S18; Sugarloaf, T23N R15E S17.

ASTERACEAE Sunflower Family

ACHILLEA
Yarrow

Achillea millefolium L.
YARROW. Common on valley floor and mountain slopes. Jun-Aug. Calpine, T21N R14E S16.

ACROPTILON Russian Knapweed

Acroptilon repens (L.) DC. RUSSIAN KNAPWEED
Disturbed roadsides and fields. May-Sep. Dyson Lane (W of Hwy 49), T22N R16E S20; Sugarloaf, T23N R15E S17 [= *Centaurea r.*].

ADENOCAULON

Adenocaulon bicolor Hook. TRAIL-PLANT
Moist shaded woods and slopes. Jun-Sep. Sattley, T20N R14E S9; Calpine, T21N R14E S20.

AGERATINA

Ageratina occidentalis (Hook.) King & Rob. WESTERN JOE PYE WEED
Rocky slopes and rocky areas along streams. Jun-Oct. To be looked in the higher elevation forest areas [= *Eupatorium o.*].

AGOSERIS Mountain Dandelion

Agoseris aurantiaca (Hook.) Greene var. ***aurantiaca*** ORANGE-FLOWERED AGOSERIS
Mountain meadows and other moist places. Jul-Aug. To be looked for in the Yuba Pass area.

Agoseris x***dasycarpa*** Greene HYBRID AGOSERIS
Wet meadows. May-Aug. Marble Lane, T22N R14E S13.

Agoseris glauca (Pursh) Raf. var. ***glauca*** MOUNTAIN AGOSERIS
Generally wet meadows. Jun-Jul. Dyson Lane, T23N R15E S31; Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R15E S18.

Agoseris grandiflora (Nutt.) Greene var. ***grandiflora*** CALIFORNIA DANDELION
Common, sagebrush scrub. Apr-Jul. Beckwourth, T23N R14E S25; Loyalton, T21N R15E S13.

Agoseris heterophylla (Nutt.) Greene var. ***heterophylla*** ANNUAL AGOSERIS
Common, open grassy areas and slopes. Apr-Jul. Marble Lane, T22N R14E S13; Antelope Valley, T21N R15E S27; Beckwourth Pass, T22N R17E S6; Calpine, T21N R14E S20.

Agoseris monticola Greene MOUNTAIN AGOSERIS
Edges of meadows and rocky slopes. Jul-Nov. Ramelli Ranch, T23N R14E S27.

Agoseris parviflora (Nutt.) D. Dietr. FALSE MOUNTAIN AGOSERIS
Open sagebrush scrub. May-Jul. Ramelli Ranch, T23N R14E S27.

Agoseris retrosa (Benth.) Greene SPEAR-LEAVED AGOSERIS
Common, dry slopes and flats. May-Jul. Calpine, T21N R14E S16 & S18; Hwy 89 (N of Sattley), T21N R14E S29.

AMBROSIA

Ambrosia acanthicarpa Hook. ANNUAL-BURWEED, SAND BUR
Disturbed sandy areas along roads. Aug-Nov. Hwy 49 (S of Vinton), T23N R16E S4; Vinton Cemetery, T23N R16E S35; Sugarloaf, T23N R15E S17.

ANAPHALIS Everlasting

Anaphalis margaritacea (L.) Benth. PEARLY EVERLASTING
Frequent in open woods. Jun-Aug. Calpine, T21N R14E S29.

ANISOCOMA

Anisocoma acaulis Torr. & A. Gray SCALE-BUD
Sandy road cuts and flats. May-Jun. Frenchman Lake Road, T23N R16E S24.

ANTENNARIA Pussytoes

Antennaria argentea Benth. SILVERY EVERLASTING
Open woods and dry open slopes. Apr-Jul. Mapes Canyon, T23N R14E S11; Antelope Valley, T21N R15E S33; Hwy 89 (N of Sattley), T21N R14E S29.

Antennaria dimorpha (Nutt.) Torr. & A. Gray LOW EVERLASTING
Common on rocky slopes and clay flats. Mar-Jun. Calpine, T21N R14E S16; Hwy 49 (N of Loyalton), T21N R16E S5; Newman Point, T21N R14E S25.

Antennaria geyeri A. Gray GEYER'S EVERLASTING
Frequent. Open sagebrush flats. Jun-Jul. Ramelli Ranch, T23N R14E S27; Dyson Lane, T23N R15E S31.

Antennaria luzuloides Torr. & A. Gray subsp. ***aberrans*** (E.E. Nelson) R.J. Bayer & Stebbins RUSH PUSSYTOES
Open meadows. May-Jul. One record for Sierra Valley (CAS917028, J.T. Howell, 37789, 18 Jun 1962; "Sierra Valley near Beckworth").

Antennaria luzuloides Torr. & A. Gray var. ***luzuloides*** SILVERY-BROWN EVERLASTING
Common on slopes and clay flats. May-Jul. Beckwourth Sattley Road, T22N R14E S11; Antelope Valley, T21N R15E S16; Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

Antennaria microphylla Rydb. SMALL-LEAVED PUSSYTOES
Fairly frequent, dry meadows. Jul-Sep. Ramelli Ranch, T22N R14E S27.

Antennaria rosea Greene ROSY EVERLASTING
Uncommon, meadow edges & rocky barrens. Jun-Aug. Sugarloaf, T23N R15E S17.

ANTHEMIS May Weed

Anthemis arvensis L. CORN CHAMOMILE
One record for Sierra Valley (UCD72551, A.M. Shapiro, "about 1.6 mi N of Sierraville," Sep. 17, 2008). Sierraville, T20N R15E S6.

Anthemis cotula L. MAY WEED, DOG FENNEL
Uncommon, disturbed areas. Apr-Aug. Sugarloaf, T23N R15E S17.

ARCTIUM Burdock

Arctium minus (Hill) Bernh. COMMON BURDOCK
Uncommon, limited to waste places. Jun-Sep. Ramelli Ranch, T23N R14 S27.

ARNICA

Arnica chamissionis Less. MEADOW ARNICA
Wet meadows. Jun-Aug. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R15E S17 [*A.c.* subsp. *foliosa*].

Arnica cordifolia Hook. HEARTLEAF ARNICA
Drying stream beds and open slopes. May-Aug. Calpine, T21N R14E S17; Ramelli Ranch, T23N R14E S27; Sattley, T20N R14E S9.

Arnica dealbata (A. Gray) B.G. Baldwin MOCK LEOPARDBANE
Drying forest meadows. Jun-Aug. Yuba Pass, T20N R13E S25 [= *Whitneya d.*].

Arnica discoidea Benth. RAYLESS ARNICA
Scattered colonies in open woods and slopes. Jun-Aug. Calpine, T21N R14E S20 & T21N R13E S24; Sierraville, T20N R15E S19.

Arnica latifolia Bong. BROADLEAF or MOUNTAIN ARNICA
Moist open places. Usually above 5500 ft. Jul-Aug. To be looked for. Found to the W in the Mohawk Valley area.

Arnica longifolia D.C. Eat. SEEP-SPRING or LONG-LEAF ARNICA
Well drained soils around springs, cliffs and streams. Jul-Aug. To be looked for in the higher elevations.

Arnica mollis Hook. HAIRY ARNICA
Common in mountain meadows, about 7000 ft. Jun-Aug. Coburn Lake, T20N R13E S29.

Arnica nevadensis A. Gray SIERRA ARNICA
Open woods and slopes. Jul-Aug. Hwy 89 (NW of Sattley), T21N R14E S29.

ARTEMISIA Sagebrush

Artemisia arbuscula Nutt. subsp. ***arbuscula*** LOW SAGEBRUSH
Common on clay flats. Jul-Aug. Beckwourth, T22N R14E S27; Calpine, T21N R14E S16.
Artemisia biennis Willd. BIENNIAL SAGEWORT
Locally frequent, moist waste places. Aug-Oct. Heriot Lane, T22N R15E S21; Ramelli Ranch, T23N R14E S26 & S28.

Artemisia cana Pursh subsp. ***bolanderi*** (A. Gray) G.H. Ward SILVER SAGEBRUSH
Locally frequent, moister portions of sagebrush flats. Aug-Sep. Beckwourth Sattley Road, T22N R14E S11; Ramelli Ranch, T23N R14E S27; Hwy 49 (W of Loyalton), T21N R15E S17.

Artemisia douglasiana Besser DOUGLAS'S MUGWORT
Common along river bottoms and waste places. Jun-Oct. Ramelli Ranch, T23N R14E S27; Sierraville, T20N R15E S7; Yuba Pass, T20N R13E S14; Sugarloaf, T23N R15E S17.

Artemisia dracunculus L. TARRAGON
Disturbed, more or less dry places. Aug-Sep. Dyson Lane, T22N R16E S18; Hwy 49 (N of Sierraville), T21N R14E S36; Sierraville, T20N R15E S6; Ramelli Ranch, T23N R14E S28.

Artemisia ludoviciana Nutt. subsp. ***incompta*** (Nutt.) D.D. Keck WHITE SAGEBRUSH
Dry open slopes. Jul-Sep. Antelope Valley, T20N R15E S3.

Artemisia ludoviciana Nutt. subsp. ***ludoviciana*** WESTERN MUGWORT
Dry open places. Jul-Sep. Ramelli Ranch, T23N R14E S29; Dyson Lane (A-24), T22N R15E S6; Sugarloaf, T23N R15E S17.

Artemisia nova A. Nels. BLACK SAGEBRUSH
Uncommon, more or less moist clay soils. Jul-Sep. Beckwourth Sattley Road, T21N R14E S9.

Artemisia tridentata Nutt. subsp ***tridentata*** GREAT BASIN SAGEBRUSH
Common, slopes and valley floor. Aug-Sep. Beckwourth Pass, T22N R17E S6.

Artemisia tridentata Nutt. subsp. ***vaseyana*** (Rydb.) Beetle MOUNTAIN SAGEBRUSH
Common on open slopes. Aug-Sep. Sierraville, T20N R15E S16.

Artemisia tridentata Nutt. subsp. ***wyomingensis*** Beetle & A. Young WYOMING BIG SAGEBRUSH
One record for the Sierra Valley Region (UTC00245787, L.M. Shultz & Heather Garrison, #20319, ca. 2 mi W of Vinton, 03 August 2006). Vinton, T23N R15E S20.

BALSAMORHIZA Balsamroot

Balsamorhiza deltoidea Nutt. DELTOID BALSAMROOT
Openings in sagebrush and woodlands. Apr-Jun. Newman Point, T21N R14E S25.

Balsamorhiza hookeri Nutt. HOOKER'S BALSAMROOT
Dry slopes and flats. May-Jul. Newman Point, T21N R14E S25; Calpine, T21N R14E S16; Sierraville, T20N R14E S13.

Balsamorhiza lanata (W.M. Sharp) W.A. Weber WOLLY BALSAMROOT
Grassy slopes. Apr-Jun. Sattley, T21N R14E S33; Hwy 70, T23N R15E S28.

Balsamorhiza sagittata (Pursh) Nutt. ARROWLEAF BALSAMROOT
Common on dry open slopes. May-Jul. Beckwourth, T23N R14E S27; Knuthson Meadows, T21N R14E S6; Newman Point, T21N R14E S25; Sugarloaf, T23N R15E S17.

BIDENS Bur-Marigold

Bidens cernua L. NODDING BUR-MARIGOLD

Edges of slow moving streams and ponds. Jul-Oct. Sierraville, T20N R14E S11; Antelope Valley, T21N R15E S17.

BLEPHARIPAPPUS

Blepharipappus scaber Hook. ROUGH EYELASH
Common, rocky slopes and arid places. Jun-Aug. Beckwourth, T23N R14E S25; Marble Lane, T22N R14E S13; Loyalton, T21N R16E S30; Beckwourth Sattley Road, T22N R14E S11.

BRICKELLIA

Brickellia microphylla (Nutt.) A. Gray LITTLE LEAVED BRICKELLIA
Uncommon, rocky areas. Jul-Oct. Sugarloaf, T23N R15E S17.

CARDUUS

Carduus acanthoides L. PLUMELESS THISTLE
Uncommon, disturbed areas and fields. Jul-Sep. Hwy 70, T23N R15E S35.

Carduus nutans L. MUSK THISTLE
Disturbed roadsides and fields. Jun-Jul. Hwy 49, T22N R16E S29; Loyalton, T21N R15E S14.

CENTAUREA Star Thistle

Centaurea cyanus L. BACHELORS BUTTON, CORNFLOWER
Scattered patches on roadsides. May-Sep. Dyson Lane (S of Hwy 70), T22N R15E S8; Calpine, T21N R14E S16.

Centaurea diffusa Lam. DIFFUSE KNAPWEED
Limited, roadside edges. May-Oct. To be eradicated whenever found. Beckwourth, T23N R15E S26; Chilcoot, T23N R16E S36.

Centaurea solstitialis L. YELLOW STAR THISTLE
Uncommon, disturbed roadsides and fields. Jun-Oct. To be eradicated whenever found. Marble Lane, T22N R14E S13; Lemmon Canyon Road, T20N R15E S17; Sugarloaf, T23N R15E S17.

Centaurea stoebe L. subsp. *micranthos* (Gugler) Hayek SPOTTED KNAPWEED
Limited, roadside edges. To be eradicated whenever found. Noxious weed. Jul-Aug. Beckwourth Sattley Road, T22N R14E S26 [= *C. maculosa*].

CHAENACTIS Pincushion

Chaenactis douglasii (Hook.) Hook. & Arn. var. ***douglasii*** DUSTY MAIDENS, HORSEWEED
Common in open forest and sagebrush slopes. Jun-Jul. Beckwourth Sattley Road, T22N R14E S34; Beckwourth Pass, T22N R17E S6; Antelope Valley, T21N R15E S21; Calpine, T21N R14E S16 & S20; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Chaenactis stevioides Hook. & Arn. DESERT PINCHUSION
Open sandy slopes. Apr-Jun. To be looked for as this taxon has been found within 1 mi of project area NE of Chilcoot.

CHRYSOTHAMNUS Rabbit-Brush

Chrysothamnus viscidiflorus (Hook.) Nutt. subsp. ***viscidiflorus*** STICKY RABBITBRUSH
Common on valley floor and slopes. Jul-Oct. Sierraville, T20N R15E S7; Marble Lane, T22N R14E S13.

CICHORIUM Chicory

Cichorium intybus L. CHICORY
Fairly frequent, roadsides. Jun-Sep. Sattley, T20N R14E S4; Loyalton, T21N R15E S13; Sugarloaf, T23N R15E S17.

CIRSIUM Thistle

Cirsium andersonii (A. Gray) Petr. ANDERSON'S THISTLE
Fairly common, dry slopes. Jun-Sep. Calpine, T21N R14E S20.

Cirsium arvense (L.) Scop. CANADA THISTLE
Scattered in roadside ditches. Jun-Sep. Sierraville, T20N R15E S7.

Cirsium canescens Nutt. PRAIRIE THISTLE
Dry scrublands. May-Aug. Two confirmed locations in Sierra Valley; 1 mi N of Loyalton on Hwy 49, Sierra Co.(CDA1132, J. Budaj, s.n.); 1 mi N of Sierra/Plumas County line on Hwy. 49, Plumas Co (CDA1126, T.C. Fuller, 17318).

Cirsium cymosum (Greene) Jeps. PEREGRINE THISTLE
Uncommon, dry rocky slopes. Jun-Aug. Antelope Valley, T21N R15E S21; The Buttes, T23N R15E S28.

Cirsium occidentale (Nutt.) Jeps. var. ***candidissimum*** (Greene) J.F. Macbr. SNOWY THISTLE
Scattered, rocky slopes. Apr-Aug. Mapes Canyon, T23N R14E S11; Sierraville, T20N R15E S6; Sugarloaf, T23N R15E S17.

Cirsium ochrocentrum A. Gray var. *ochrocentrum* YELLOW SPINED THISTLE
Uncommon, introduced from central U.S. Apr-Jul. Hwy 49, T22N T16E S32; Loyalton, T21N R15E S13.

Cirsium scariosum Nutt. ELK THISTLE
Common in meadows. Jun-Aug. Antelope Valley, T21N R15E S16; Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Cirsium undulatum (Nutt.) Spreng. WAVYLEAF THISTLE
Disturbed areas. Jun-Aug. Hwy 49 (1 mi N of Sierra-Plumas Co. line), T22N R16E S29.

Cirsium vulgare (Savi) Ten. BULL THISTLE
Common, roadside ditches. May-Oct. Sierraville, T20N R15E S7; Sugarloaf, T23N R15E S17.

CREPIS Hawksbeard

Crepis acuminata Nutt. LONG-LEAF HAWKSBEARD
Frequent, sagebrush flats and slopes. May-Aug. Newman Point, T21N R14E S25; Sugarloaf, T23N R15E S17.

Crepis bakeri Greene subsp. ***bakeri*** BAKER'S HAWKSBEARD
Widely scattered. Jul-Aug. Marble Lane, T22N R15E S18; Newman Point, T21N R14E S25; E slope of Beckwourth Peak, T22N R14E S9; Calpine, T21N R14E S29.

Crepis intermedia A. Gray. INTERMEADIATE HAWKSBEARD
Common, dry rocky sagebrush scrub. Jun-Aug. Loyalton, T21N R15E S27; Newman Point, T21N R14E S25; Antelope Valley, T21N R15E S27.

Crepis modocensis Greene subsp. ***subacaulis*** (Kellogg) Babc. & Stebbins LOW HAWKSBEARD
Fairly common, open areas in pines on the edges of the valley. Jun-Aug. Sattley, T20N R14E S33; Beckwourth Sattley Road, T22N R14E S26.

Crepis occidentalis Nutt. subsp. ***costata*** (A. Gray) Babc. & Stebbins WESTERN HAWKSBEARD
Uncommon, dry rocky flats. Jun-Jul. Newman Point, T21N R14E S25.

Crepis occidentalis Nutt. subsp. ***occidentalis*** WESTERN HAWKSBEARD
Common, dry rocky flats. Jun-Jul. Newman Point, T21N R14E S25; Loyalton, T21N R16E S29.

Crepis occidentalis Nutt. subsp. ***pumila*** (Rydb.) Babc. & Stebbins WESTERN HAWKSBEARD
Uncommon, dry rocky flats. Jun-Jul. Newman Point, T21N R14E S25; Loyalton, T21N R16E S29; Sierraville, T20N R15E S19.

Crepis runcinata (E. James) Torr. & A.Gray subsp. ***andersonii*** (A. Gray) Babc. & Stebbins ANDERSON'S MEADOW HAWKSBEARD
Meadows and subalkaline flats. One record for Sierra Valley, (RENO20825 & CAS824120; W. & N. Harnach, 146, Jun 17, 1989). Jun-Jul. Marble Lane, T22N R14E S17.

DIETERIA

Dieteria canescens (Pursh) Nutt. var. ***canescens*** HOARY ASTER
Fairly frequent, dry sandy or gravelly slopes. Jul-Sep. Beckwourth, T23N R14E S27; Calpine, T21N R14E S16; Antelope Valley, T21N R15E S8; Sugarloaf, T23N R15E S17 [= *Machaeranthera c.* var. *c.*].

ERICAMERIA

Ericameria bloomeri (A. Gray) J.F. Macbr. BLOOMER'S GOLDENBUSH
Fairly common. Jul-Oct. Hwy 49 Vista Point, T21N R14E S31; Ramelli Ranch, T23N R14E S28.

Ericameria nauseosa (Pall.) Nesom & Baird var. ***oreophila*** (A. Nels.) Nesom & Baird YELLOW-GREEN RABBITBRUSH
Common on the valley floor with sagebrush. Jul-Sep. Dyson Lane, T22N R15E S16; Marble Lane, T22N R14E S13; Sierraville, T20N R15E S6 [= *Chrysothamnus n.* subsp. *consimilis*].

Ericameria nauseosa (Pall.) Nesom & Baird var. ***speciosa*** (Nutt.) Nesom & Baird RUBBER RABBITBRUSH
Sagebrush scrub. Aug-Oct. Sierraville, T20N R15E S20; Heriot Lane, T21N R15E S9; Beckwourth Pass, T22N R17E S6 [= *Chrysothamnus n.* subsp. *albicaulis*].

Ericameria parryi (A. Gray) Nesom & Baird var. ***nevadensis*** (A. Gray) Nesom & Baird PARRY'S RABBITBRUSH
Sagebrush scrub and open forest. Jul-Sep. Ramelli Ranch, T23N R14E S27; Hwy 49 (N of Sierraville), T21N R14E S36; Beckwourth, T23N R14E S26; Calpine, T21N R14E S16 [= *Chrysothamnus p.* subsp. *n.*].

ERIGERON Wild Daisy

Erigeron aphanactis (A. Gray) Greene var. ***aphanactis*** BASIN RAYLESS DAISY
Sagebrush and juniper scrub. Apr-Sep. Two historical records for Sierra Valley (CAS6216, Alice Eastwood, #7855, Jul 29, 1918, Loyalton & JEPS41414, J.G. Lemmon, Sierra Valley).

Erigeron barbellulatus Greene SHINING DAISY
Rocky slopes and ridge tops. Jun-Jul. Beckwourth Peak, T22N R14E S9.

Erigeron bloomeri A. Gray var. ***bloomeri*** BLOOMER'S DAISY
Sagebrush scrub and slopes. Jun-Aug. Marble Lane, T22N R14E S13; Antelope Valley, T21N R15E S33.

Erigeron canadensis L. HORSEWEED
Disturbed areas. Jun-Sep. Calpine, T21N R14E S16 & S17; Ramelli Ranch, T23N R14E S27 [= *Conyza c.*].

Erigeron chrysopsidis A. Gray subsp. ***austiniae*** (Greene) Cronq. AUSTIN'S FLEABANE
Sagebrush scrub and rocky slopes. May-Jun. To be looked for as this taxon has been found just to the N of Sierra Valley in the Crystal Peak, Plumas Co. area [= *Erigeron austiniae*].

Erigeron coulteri Porter COULTER'S DAISY
Stream banks and wet meadows. Jul-Aug. Coburn Lake, T20N R14E S29.

Erigeron divergens Torr. & A. Gray DIFFUSE DAISY
Fairly common, moist or dry sandy soils. May-Oct. Beckwourth, T23N R14E S11; Loyalton, T21N R15E S27; Antelope Valley, T21N R15E S17; Sugarloaf, T23N R15E S17.

Erigeron eatonii A. Gray var. ***nevadincola*** (S.F. Blake) G.L. Nesom NEVADA DAISY
Uncommon, rocky volcanic soils. CRPR 2B. May-Jul. Newman Point, T21N R14E S25; Antelope Valley, T21N R15E S16.

Erigeron eatonii A. Gray var. ***plantagineus*** (Greene) Cronq. EAT.'S DAISY
Clay flats, sagebrush scrub. Apr-Jun. Calpine, T21N R14E S16.

Erigeron eatonii A. Gray var. ***sonnei*** (Greene) Nesom EAT.'S DAISY
Infrequent, rocky slopes and sagebrush scrub. May-Jun. Loyalton, T21N R16E S8; Ramelli Ranch, T23N R14E S27; Antelope Valley, T21N R15E S17; Sattley, T20N R14E S4.

Erigeron filifolius (Hook.)Nutt. THREAD-LEAVED DAISY
Fairly common, dry sandy soils, open pine forest. Jun-Aug. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Beckwourth Pass, T22N R17E S6; Sugarloaf, T23N R15E S17.

Erigeron glacialis (Nutt.) A. Nels. var. ***glacialis*** WANDERING DAISY
Forest clearings and meadows. Jul-Sep. Yuba Pass Road, T20N R13E S25 [= *E. peregrinus* var. *callianthemus*].

Erigeron inornatus (A. Gray) A. Gray var. ***inornatus*** CALIFORNIA RAYLESS DAISY
Conifer forests. Jun-Sep. Sattley, T21N R14E S32; Calpine, T21N R14E 20.

Erigeron lassenianus Greene var. ***lassenianus*** LASSEN DAISY
Gravelly soils on meadow edges. Jun-Sep. Sattley, T21N R14E S32; Antelope Valley, T21N R15E S35.

Erigeron linearis (Hook.) Piper DESERT YELLOW DAISY
Sagebrush scrub and open slopes. May-Jul. To be looked for as this taxon has been collected just N of Sierra Valley.

Erigeron petrophilus Greene var. ***viscidulus*** (A. Gray) G.L. Nesom KLAMATH DAISY
Rocky slopes and forest. Jul-Sep. One historical record for Sierra Valley (JEPS41436, J.G. Lemmon, Jul 1, 1883, Sierra Valley).

Erigeron pumilus Nutt. var. ***intermedius*** Cronq. HAIRY DAISY
Fairly common, valley floor and open slopes. Jun-Aug. Marble Lane, T22N R14E S13; Loyalton, T21N R16E S5; Hwy 49 (S of Vinton), T22N R16E S10; Ramelli Ranch, T23N R14E S27.

ERIOPHYLLUM

Eriophyllum lanatum (Pursh) J. Forbes var. ***integrifolium*** (Hook.) Smiley OREGON SUNSHINE
Common, sagebrush slopes, sandy flats. Jun-Sep. Ramelli Ranch, T23N R14E S27; Loyalton, T21N R15E S16.

EUCEPHALUS Aster

Eucephalus breweri (A. Gray) Nesom BREWER'S ASTER
Meadows and open forest. Jul-Oct. Coburn Lake, T20N R13E S29; Yuba Pass, T20N R13E S14 [= *Aster b.*].

EURYBIA

Eurybia integrifolia (Nutt.) Nesom ENTIRE LEAVED ASTER
Forest floor and edges of dry meadows. Jul-Sep. Coburn Lake, T20N R13E S29; Calpine, T21N R14E S20 [= *Aster integrifolius*].

GNAPHALIUM Cudweed

Gnaphalium palustre Nutt. WESTERN MARSH CUDWEED
Roadside ditches and drying potholes. May-Oct. Calpine, T21N R14E S17 & S20; Beckwourth Sattley Road (at Calpine Road), T21N R14E S16; Ramelli Ranch, T23N R14E S27; Sattley, T21N R14E S33; Sugarloaf, T23N R15E S17.

GRINDELIA Gumweed

Grindelia nana Nutt. IDAHO RESIN-WEED
Locally common, open rocky slopes and roadsides. Jul-Sep. Beckwourth Pass, T23N R17E S6; Hwy 49 (S of Vinton), T22N R16E S4; Calpine, T21N R14E S20.

Grindelia squarrosa (Pursh) Dunal var. *serrulata* (Rydb.) Steyerm. RESIN-WEED
Disturbed areas and roadsides. Jul-Sep. Sattley, T20N R14E S4; Beckwourth, T23N R14E S27; Chilcoot, T232N R16E S36.

GUTIERREZIA

Gutierrezia sarothrae (Pursh) Britton & Rusby COMMON SNAKEWEED
Sagebrush slopes. May-Oct. Two historical sheets from Sierra Valley (UC196513, unknown, Aug. 1, 1880, Sierra Valley, from Lemmon Herbarium & DS206063, Lemmon, s.n., Aug. 1880, Sierra Co., Sierra Valley). This taxon was probably collected in Santa Barbra Co. based on the date and range of species.

HAZARDIA

Hazardia whitneyi (A. Gray) Greene WHITNEY'S GOLDENBUSH
Open forest. Jul-Sep. Calpine, T21N R14E S19.

HELIANTHELLA

Helianthella californica A. Gray var. ***nevadensis*** (Greene) Jeps. SIERRA NEVADA HELIANTHELLA
Open forest and meadows. May-Sep. Ramelli Ranch, T23N R14E S27; Antelope Valley, T21N R15E S33; Sugarloaf, T23N R15E S17.

HELIANTHUS Sunflower

Helianthus annuus L. COMMON SUNFLOWER
Scattered, roadsides and dry stream areas. Jul-Aug. Lemmon Canyon, T20N R15E S17; Calpine, T21N R14E S29.

Helianthus bolanderi *A.* Gray BOLANDER'S SUNFLOWER
Uncommon, disturbed areas and roadsides. Jul-Oct. Calpine, T21N R14E S20 & S29.

Helianthus exilis A. Gray SERPENTINE SUNFLOWER
Sagebrush flats and gravelly streams. Jun-Oct. One record for Sierra Valley (CAS896342, Lewis S. Rose, #55162, Jul 20, 1955, 2 mi S of Calpine).

HEMIZONELLA Tarweed

Hemizonella minima (A. Gray) A. Gray DWARF TARWEED
Common, open flats and slopes. May-Jul. Sattley, T20N R14E S9 & S28; Calpine, T21N R14E S16; Beckwourth Sattley Road, T22N R14E S2 [*Madia m.*].

HETEROTHECA Goldenaster

Heterotheca villosa (Pursh) Shinners var. ***minor*** (Hook.) Semple TELEGRAPH WEED
Frequent, sandy areas and roadsides. Jul-Sep. Hwy 70, T23N R15E S35; Dyson Lane, T22N R15E S14; Beckwourth Sattley Road, T22N R14E S11; Ramelli Ranch, T23N R14E S27; Chilcoot, T23N R16E S24.

HIERACIUM Hawkweed

Hieracium albiflorum Hook. WHITE-FLOWERED HAWKWEED
Frequent, dry wooded slopes. Jun-Aug. Calpine, T21N R14E S18; Sattley, T20N R14E S9.

Hieracium greenei A. Gray GREENE'S HAWKWEED
Dry forest slopes. Jul-Sep. One historical record for Sierra Valley (UC194105, unknown, Jul 1, 1887, from the Lemmon Herbarium). Also found at Haskell Peak and several other locations just outside the project area.

HYMENOXYS

Hymenoxys lemmonii (Greene) Cockerell LEMMON'S GOLDFLOWER
Fairly frequent. Subalkaline areas. CRPR 2B. Jun-Jul. Dyson Lane, T22N R16E S17; Marble Lane, T22N R15E S18; Hwy 49, T22N R16E S8; Hwy 70, T23N R15E S30; Loyalton, T21N R15E S13.

HYPOCHAERIS Cat's Ear

Hypochaeris radicata L. ROUGH CAT'S EAR
Waif, disturbed roadside. Jul-Aug. Calpine, T21N R14E S17.

IONACTIS Aster

Ionactis alpina (Nutt.) Greene LAVA ASTER
Uncommon, dry rocky places. May-Jul. Sugarloaf, T23N R15E S17 [= *Aster scopulorum*].

IVA Marsh-Elder

Iva axillaris Pursh POVERTY WEED
Subalkaline areas. Jun-Aug. 6 Mile Road (A-24 N from Loyalton), T22N R15E S24; Marble Lane, T22N R14E S13; Sugarloaf, T23N R15E S17.

KYHOSIA

Kyhosia bolanderi (A. Gray) B.G. Baldwin BOLANDER'S MADIA
Meadows and stream banks. Jul-Sep. Yuba Pass, T20N R13E S11; Sattley, T20N 14E S30 [= *Madia b.*].

LACTUCA Wild Lettuce

Lactuca saligna L. WILLOW LETTUCE
Infrequent, waste places. Jun-Aug. Ramelli Ranch, T23N R14E S27.

Lactuca serriola L. PRICKLY LETTUCE
Common, waste places and disturbed areas. Jun-Oct. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

Lactuca tatarica (L.) C.A. Mey. subsp. ***pulchella*** Stebbins BLUE LETTUCE
Dry to moist flats. Jun-Sep. One historic collection for Sierra Valley (JEPS36696, J.G. Lemmon, Sierra Valley, s.n., no date).

LAGOPHYLLA

Lagophylla ramosissima Nutt. COMMON HARELEAF
Open slopes and waste places. Jun-Oct. Beckwourth Sattley Road, T21N R14E S28 & S11; Ramelli Ranch, T23N R14E S27; Sierraville, T20N R15E S7; Sugarloaf, T23N R15E S17.

LAYIA

Layia glandulosa (Hook.) Hook. & Arn. WHITE LAYIA
Infrequent. Open sandy areas and dry rocky soils. May-Jun. Antelope Valley, T21N R15E S27; East of Beckwourth, T23N R14E S32; Sugarloaf, T23N R15E S17.

Layia platyglossa (Fisch. & C.A. Mey.) A. Gray COASTAL TIDYTIPS
Introduced as part of Hwy work. Hwy 70 at Plumas County Airport, T23N R15E S30.

LEUCANTHEMUM Ox-Eye Daisy

Leucanthemum vulgare Lam. OX-EYE DAISY
Uncommon, disturbed places. Jun-Aug. Sierraville, T20N R14E S10.

MADIA Tarweed

Madia citrigracilis D.D. Keck SHASTA TARWEED
Widely scattered, sagebrush scrub. May-Jul. Marble Lane, T22N R14E S13.

Madia citriodora Greene LEMON-SCENTED TARWEED
Open disturbed sites. May-Jul. Calpine, T21N R14E S16.

Madia elegans D. Don COMMON MADIA
Open disturbed sites. Jun-Sep. Calpine, T21N R14E S16; Antelope Vally, T21N R15E S33; Frenchman Lake Road, T23N R16E S24; Sattley, T20N R14E S9; Beckwourth Sattley Road, T21N R14E S28.

Madia exigua (Sm.) A. Gray LITTLE TARWEED
Grassy and disturbed sites. Apr-Jul. Sugarloaf, T23N R15E S17; Calpine, T21N R15E S16.

Madia glomerata Hook. MOUNTAIN TARWEED
Open woods and slopes. Jul-Sep. Calpine, T21N R14E S16; Hwy 49 (Vista Point), T21N R14E S31; Antelope Valley, T21N R15E S17; Ramelli Ranch, T23N R14E S27.

Madia gracilis (Sm.) Applegate SLENDER TARWEED
Wooded slopes and dry stream beds. May-Oct. Mapes Canyon, T23N R14E S11.

MALACOTHRIX Woolly Dandelion

Malacothrix floccifera WOOLLY DANDELION
Scattered, open slopes. Jun-Aug. Calpine, T21N R14E S17.

MATRICARIA

Matricaria discoidea DC. PINEAPPLE WEED
Common in disturbed areas and waste places. Mar-Jun. Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17 [= *Chamomilla sauveolens*].

MICROSERIS

Microseris nutans (Hook.) Sch.-Bip. NODDING MICROSERIS
Open moist woods. Jun-Aug. Coburn Lake, T20N R14E S29; Calpine, T21N R14E S20.

NOTHOCALAIS False-Agoseris

Nothocalais troximoides (A. Gray) Greene WAVY-LEAF FALSE AGOSERIS
Common, open sagebrush scrub and dry meadows. May-Jun. Calpine, T21N R14E S16; Antelope Valley, T21N R15E S17.

ONOPORDUM

Onopordum acanthium L. subsp. *acanthium* SCOTTISH THISTLE
Disturbed sites, invasive weed. May-Aug. Hwy. 70 (4.85 W of Vinton), T23N R15E S35

OREOSTEMMA

Oreostemma alpigenum (Torr. & A. Gray) Greene var. ***andersonii*** (A. Gray) Nesom ALPINE ASTER, TUNDRA ASTER
Montane meadows. Jun-Sep. Yuba Pass, T20N R13E S11; Coburn Lake, T20N R13E S29 [= *Aster a.*].

Oreostemma elatum (Greene) Greene TALL ALPINE-ASTER
Wet meadows, marshy areas and peatlands. CRPR 1B. Jul-Aug. Yuba Pass, T20N R13E S11 [= *Aster elatus*].

PACKERA Groundsel, Butterweed

Packera cana (Hook.) W.A.Weber & A. Löve WOOLLY GROUNDSEL
Rocky slopes. Jun-Aug. To be looked for, found just to the N at Dixie Mountain [= *Senecio c.*].

Packera pauciflora (Pursh) A. Love & D. Löve ALPINE GROUNDSEL
Wet meadows. Jun-Aug. Sattley, T20N R14E S9; Hwy 70, T23N R15E S30 [= *Senecio p.*].

Packera pseudaurea (Rydb.) W.A. Weber & A. Löve var. ***pseudaurea*** FALSE-GOLD GROUNDSEL
Stream banks and wet meadows. Jun-Jul. Sierraville, T20N R14E S13 [= *Senecio p.* var. *p.*].

Packera streptanthifolia (Greene) W.A. Weber & A. Löve var. ***streptanthifolia*** ROCKY MOUNTAIN GROUNDSEL
Uncommon, ± alakiline meadows and wet acidic meadows. May-Jul. Dyson Lane (A-24), T23N R15E S31; Sattley, T20N R14E S9; Sierraville, T21N R14E S13 [= *Senecio s.*].

PLEIACANTHUS (Stephanomeria)

Pleiacanthus spinosus (Nutt.) Rydb. THORNY SKELETON-PLANT
Uncommon, open sandy slopes and ridges. Jul-Sep. Little Last Chance Creek (N of Chilcoot), T23N R16E S24; Ross Ranch Meadows (Ramelli Ranch), T23N R13E S34; Sierraville (Hwy 49 to Loyalton), T20N R14E S6; Beckwourth Sattley Road, T22N R14E S12; Sugarloaf, T23N R15E S17 [= *Stephanomeria s.*].

PSEUDOGNAPHALIUM Cudweed

Pseudognaphalium canescens (DC.) Anderb. WRIGHT'S CUDWEED
Rocky sites and woodlands. Aug-Oct. Calpine, T21N R14E S19.

Pseudognaphalium luteoalbum (L.) Hilliard & B.L. Burtt JERSEY CUDWEED
Disturbed sites, fields, drying streambeds. Apr-Aug. Chilcoot, T23N R16E S35.

Pseudognaphalium microcephalum (Nutt.) Anderb. WRIGHT'S CUDWEED
Wet meadows. Jun-Aug. Sattley, T20N R14E S9.

Pseudognaphalium stramineum (Kunth) Anderb. COTTON-BATTING CUDWEED
Scattered, moist disturbed places and roadsides. Jun-Nov. Frenchman Lake Road, T23N R16E S13 [= *Gnaphalium s.*].

Pseudognaphalium thermale (E.E. Nelson) Nesom SMALL-HEADED CUDWEED
Fairly common, open meadow. Aug-Sep. Sattley, T20N R14E S9; Calpine, T21N R14E S20; Sugarloaf, T23N R15E S17.

PSILOCARPHUS Woolly-Marbles

Psilocarphus brevissimus Nutt. var. ***brevissimus*** DWARF WOOLY-HEADS
Frequent, vernal pools and roadside ditches. Jun-Jul. Marble Lane, T22N R14E S13; Ramelli Ranch, T23N R14E S27 & S26; Beckwourth Sattley Road, T21N R14E S9.

Psilocarphus oregonus Nutt. OREGON WOLLY HEADS
Vernally moist areas. May-Jun. Beckwourth Sattley Road, T21N R14E S9; Ross Ranch Meadows, T23N R14E S28.

Psilocarphus tenellus Nutt. SLENDER WOOLY-HEADS
Frequent, dried vernal areas and roadside ditches. Apr-Jun. Marble Lane, T22N R14E S13.

PYRROCOMA

Pyrrocoma apargioides (A. Gray) Greene ALPINE PYRROCOMA
Sandy sagebrush scrub. Jun-Jul. Hwy 70 (E of the Buttes), T23N R14E S34.

Pyrrocoma carthamoides Hook. var. ***cusickii*** (A. Gray) Kartesz & Gandhi CUSICK'S PYRROCOMA
Barren rocky areas. Jun-Sep. Sugarloaf, T23N R15E S17.

Pyrrocoma lanceolata (Hook.) Greene var. ***lanceolata*** INTERMOUNTAIN PYRROCOMA
Meadows and alkaline flats. Jun-Sep. Dyson Lane, T22N R16E S18; Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Hwy 49, T21N R15E S16; Hwy 70, T23N R15E S34.

Pyrrocoma lucida (D.D. Keck) Kartesz & Gandhi STICKY PYRROCOMA
Localized stands. Meadow areas in pines and sagebrush. CRPR 1B. Jul-Oct. Calpine, T21N R14E S16; Beckwourth Sattley Road, T21N R14E S10; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Pyrrocoma racemosa (Nutt.) Torr. & A. Gray var. ***paniculata*** (Nutt.) Kartesz & Gandhi TIGHT-FLOWERED PYRROCOMA
Limited, drying alkaline flats. Jul-Oct. Chilcoot, T23N R16E S36; Vinton, T23N R16E S34; Snow Lake (N of Chilcoot), T23N R17E S6.

Pyrrocoma uniflora (Hook.) Greene var. ***uniflora*** ONE FLOWERED PYRROCOMA
Uncommon, alkaline meadows. May-Sep. Hwy 70, T23N R15E S34 & S30.

RIGIOPAPPUS

Rigiopappus leptocladus A. Gray BRISTLEHEAD
Sagebrush scrub. Apr-Jun. Sattley, T21N R14E S28; Ramelli Ranch, T23N R14E S27; Newman Point, T21N R14E S25; Sugarloaf, T23N R15E S17.

SENECIO Butterweed

Senecio aronicoides DC. RAYLESS RAGWORT
Open woods and brushy slopes. Apr-Jul. Yuba Pass, T20N R13E S11.

Senecio hydrophiloides Rydb. SWEET MARSH RAGWORT
Uncommon. Wet meadows and seeps. CRPR 4. May-Jul. Dyson Lane, T22N R16E S17.

Senecio hydrophilus Nutt. ALKALI-MARSH RAGWORT
Stream banks and marshes. May-Aug. Marble Lane, T22N R15E S19.

Senecio integerrimus *Nutt.* var. ***exaltatus*** (Nutt.) Cronq. COLUMBIA RAGWORT
Open slopes and open woodlands. May-Sep. Calpine, T21N R14E S29 & S21; Antelope Valley, T21N R15E S28; Ramelli Ranch, T23N R14E S26; Sugarloaf, T23N R15E S17.

Senecio integerrimus *Nutt.* var. ***major*** (A. Gray) Cronq. LAMBS-TONGUE RAGWORT
Sagebrush scrub. May-Aug. One record for Sierra Valley (UC585148, E.B. Babcock, G.L. Stebbins, #1680, Jun 3, 1936, "e side; on road to Loyalton, Sierra Valley").

Senecio scorzonella Greene SIERRA RAGWORT
Open forest and mountain meadows. Jul-Aug. Coburn Lake, T20N R13E S29.

Senecio serra Hook. var. ***serra*** TALL RAGWORT
Open stream banks and sagebrush scrub. Jul-Aug. Sierraville, T21N R14E S13.

Senecio triangularis Hook. ARROWLEAF RAGWORT
Wet meadows and stream banks. Jun-Sep. Sattley, T20N R14E S9; Sierraville, T21N R14E S13.

Senecio vulgaris L. COMMON GROUNDSEL
Uncommon, waste places. Jun-Oct. Loyalton, T21N R15E S12.

SOLIDAGO Goldenrod

Solidago elongata Nutt. CANADA GOLDENROD
Wet meadows and roadside ditches. Jun-Oct. Sierraville, T20N R14E S22; Sattley, T20N R14E S4 [= *S. canadensis* subsp. *e.*].

Solidago spectabilis (D.C. Eat.) A. Gray SHOWY GOLDENROD
Bogs and alkaline meadows. Jul-Aug. Sattley, T20N R14E S10.

Solidago velutina DC. subsp. ***californica*** (Nutt.) Semple VELVETY GOLDENROD
Woodland margins and meadows. Aug-Sep. Calpine, T21N R14E S21 & S17.

SONCHUS Sow Thistle

Sonchus asper (L.) Hill subsp. *asper* PRICKLY SOW THISTLE
Moist disturbed sites. Jun-Oct. Ramelli Ranch, T23N R14E S27.

SPHAEROMERIA Chickensage

Sphaeromeria potentilloides (A. Gray) A. Heller var. ***potentilloides*** BRASS BUTTONS, FIVEFINGER CHICKENSAGE
Uncommon, alkaline areas. May-Jul. Loyalton, T21N R15E S12; Dyson Lane, T22N R14E S6.

STENOTUS

Stenotus acaulis (Nutt.) Nutt. CUSHION STENOTUS
Dry rocky ridges and slopes. May-Jul. Loyalton (Elephant Head), T21N R16E S8; Sugarloaf, T23N R15E S17.

STEPHANOMERIA

Stephanomeria exigua Nutt. subsp. ***coronaria*** (Greene) Gottlieb SMALL STEPHANOMERIA
Volcanic soils in sagebrush scrub. Jul-Aug. Chilcoot, T23N R16E S25.

Stephanomeria lactucina A. Gray FOREST STEPHANOMERIA
Forest and dry slopes and flats. Jul-Aug. Yuba Pass, T20N R13E S11; Calpine, T21N R14E S20.

Stephanomeria virgata Benth. subsp. ***pleurocarpa*** (Greene) Gottlieb TALL STEPHANOMERIA
Sagebrush scrub. Jun-Oct. Sugarloaf, T23N R15E S17.

SYMPHYOTRICHUM Western Aster

Symphyotrichum ascendens (Lindl.) Nesom LONG-LEAVED ASTER or WESTERN ASTER
Stream banks and meadows. Jul-Sep. Sierraville, T20N R15E S7; Calpine, T21N R14E S16; Coburn Lake, T20N R13E S29; Beckwourth Sattley Road, T21N R14E S10; Hwy.70, T23N R15E S34 [= *Aster a.*].

Symphyotrichum bracteolatum (Nutt.) Nesom EATON'S ASTER
Wet meadows and stream banks. Jul-Sep. Sattley, T20N R14E S9; Sierraville, T20N R14E S22 [= *Aster eatonii*].

Symphyotrichum campestre (Nutt.) Nesom WESTERN MEADOW ASTER
Dry meadows, slopes and open forest. Jul-Sep. Beckwourth, T23N R14E S25; Dyson Lane (S of Hwy 70), T23N R14E S30; Beckwourth Sattley Road, T22N R14E S12; Sugarloaf, T23N R15E S17 [= *Aster c.*].

Symphytorichum chilense (Nees) Nesom PACIFIC ASTER
Grasslands and disturbed areas. Jun-Oct. Junction of Hwy. 70 & Hwy 49 at Vinton, T23N R16E S34. [= *Aster c.*]

Symphyotrichum foliaceum (DC.) Nesom var. ***parryi*** (D.C. Eat.) G.L. Nesom PARRY'S ASTER
Wet montane meadows. Jul-Aug. To be looked for as this taxon has been collected just outside the project area [= *Aster f.*].

Symphyotrichum frondosum (Nutt.) Nesom SHORT-RAYED ALKALI ASTER
Moist alkaline flats. Aug-Oct. Hwy 49, T22N R16E S4; Chilcoot, T23N R16E S36 [= *Aster f.*].

Symphyotrichum spathulatum (Lindl.) Nesom var. ***spathulatum*** WESTERN MOUNTAIN ASTER
Meadows. Jun-Aug. Calpine, T21N R14E S20; Marble Lane, T22N R15E S18 [= *Aster occidentalis* var. *o.*].

TANACETUM

Tanacetum vulgare L. TANSY
Uncommon, disturbed roadside. Aug-Oct. Sattley, T20N R14E S10; Beckwourth Sattley Road (Van Vleck Ranch), T21N R14E S22.

TARAXACUM

Taraxacum officinale F.H. Wigg. COMMON DANDELION
Common throughout the valley. Can bloom any time of the year. Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

TETRADYMIA

Tetradymia canescens DC. HORSEBRUSH
Open dry slopes and sagebrush scrub. Aug-Oct. Calpine, T21N R14E S16; Beckwourth Pass, T22N R17E S6; Newman Point, T21N R14E S25; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Tetradymia glabrata Torr. & A. Gray LITTLE LEAF HORSEBRUSH
Sagebrush scrub. May-Jul. One collection for Sierra Valley (UC1070371, N. French, #561, Nov. 16, 1934). Beckwourth Sattley Road (8 mi S of Beckwourth), T21N R14E S3.

TRAGOPOGON

Tragopogon dubius Scop. YELLOW SALSIFY
Disturbed areas and waste places. May-Jul. Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Tragopogon porrifolius L. PURPLE SALSIFY
Disturbed roadsides and waste places. Jun-Aug. Sierraville, T20N R14E S13.

TRIPLEUROSPERMUM

Tripleurospermum inodorum (L.) Sch.-Bip. FALSE-CHAMOMILE
Dry disturbed sandy soils. Jul-Sep. One collection for Sierra Valley (JEPS113930, W. & N. Harnach, #990, Aug. 23, 2000). Dyson Lane, T22N R16E S18.

WYETHIA Mule-Ears

Wyethia angustifolia (DC.) Nutt. NARROWLEAF MULE-EARS
Sagebrush scrub and slopes. Apr-Jun. Calpine, T21N R14E S16.

Wyethia mollis A. Gray MOUNTAIN MULE-EARS
Sagebrush slopes and flats. May-Aug. Ramelli Ranch, T23N T14E S27; Frenchman Lake Road, T23N R16E S13; Sugarloaf, T23N R15E S17.

XANTHIUM

Xanthium strumarium L. COCKLEBUR
Waste places and dry stream beds. Jul-Sep. Loyalton, T21N R15E S1.

BERBERIDACEAE Barberry Family

BERBERIS Oregon-Grape

Berberis aquifolium Pursh var. ***repens*** (Lindl.) Scoggan CREEPING OREGON GRAPE
Uncommon, stream banks. Apr-Jun. Sugarloaf, T23N R15E S17; Ramelli Ranch, T22N R14E S27.

BETULACEAE Birch Family

ALNUS Alder

Alnus incana (L.) Moench subsp. ***tenuifolia*** (Nutt.) Breitung MOUNTAIN ALDER
Common, edges of meadows and streams. Apr-May. Sattley, T20N R14E S9, Calpine, T21N R14E S16.

BORAGINACEAE Borage or Waterleaf Family

AMSINCKIA Fiddleneck

Amsinckia intermedia Fisch. & C.A. Mey. COMMON FIDDLENECK
Open disturbed areas. May-Jul. One record for Sierra Valley (SJSU14314, N.A. Hopkins, #1504, Jun 6, 1989). Loyalton, T21N R16E S12 [= *Amsinckia menziesii* var. *i.*].

Amsinckia menziesii (Lehm.) A. Nels. & J.F. Macbr. MENZIES' FIDDLENECK
Infrequent, along roads and in fields. Apr-Jun. Beckwourth Sattley Road, T22N R14E S11.

Amsinckia tessallata A. Gray. var. ***tessallata*** CHECKER FIDDLENECK
Local, dry sandy areas on slopes and valley floor. May-Jun. Hwy 49, T22N R16E S8; Sugarloaf, T23N R15E S18.

CRYPTANTHA

Cryptantha affinis (A. Gray) Greene COMMON CRYPTANTHA
Dry open slopes. Jun-Jul. Mapes Canyon, T23N R14E S11; Sattley, T20N R14E S9; Sierraville, T20N R15E S18.

Cryptantha ambigua (A. Gray) Greene WILKE'S CRYPTANTHA
Dry sandy slopes and flats. Jun-Jul. Hwy 49, T22N R16E S4.

Cryptantha circumscissa (Hook. & Arn.) I.M. Johnst. var. ***circumscissa*** WESTERN CRYTANTHA
Dry sandy openings in sagebrush. May-Jun. Beckwourth Pass, T22N R17E S6; Vinton, T23N R16E S28; Sugarloaf, T23N R15E S17.

Cryptantha echinella Greene PRICKLEY CRYPTANTHA
Gravely or rocky soils. May-Aug. Sugarloaf, T23N R15E S17.

Cryptantha intermeadia (A. Gray) Greene COMMON CRYPTANTHA
Sagebrush scrub. May-Jul. Sattley, T20N R14E S33.

Cryptantha pterocarya (Torr.) Greene var. ***purpusii*** Jeps. WING-NUT CRYPTANTHA
Sandy openings in sagebrush. Jun-Jul. Beckwourth Pass, T22N R17E S6.

Cryptantha simulans Greene PINE CRYPTANTHA
Dry open woods and gravelly sites. May-Aug. Sugarloaf, T23N R15E S17; Yuba Pass, T20N R13E S11.

Cryptantha torreyana (A. Gray) Greene var. ***torreyana*** TORREY'S CRYPTANTHA
Sandy to gravelly dry slopes. May-Aug. Beckwourth, T23N R14E S11; Calpine, T21N R14E S16; Antelope Valley, T21N R15E S28.

Cryptantha watsonii (A. Gray) Greene WATSON'S CRYPTANTHA
Open sandy slopes and small sand dunes. Jun-Aug. Frenchman Lake Road, T23N R16E S25

CYNOGLOSSUM Hound's Tongue

Cynoglossum officinale L. COMMON HOUND'S TONGUE
Disturbed logged areas. May-Jul. To be looked for as this taxon has been collected just outside the project boundary.

ERIODICTYON Yerba Santa

Eriodictyon lobbii (A. Gray) Greene LOBBS NAMA
Uncommon, dry sandy or rocky slopes. Jun-Aug. SE of Yuba Pass, T20N R14E S17. [= *Nama l.*]

HACKELIA Stickseed

Hackelia floribunda (Lehm.) I.M. Johnst. MANY FLOWERED STICKSEED
Uncommon, vernally wet areas. Jun-Aug. Coburn Lake, T20N R14E S29.

Hackelia micrantha (Eastw.) J.L. Gentry SMALL-FLOWERED STICKSEED
Locally frequent, moist areas, partial shade. Jun-Aug. Yuba Pass, T20N R13E S11.

Hackelia setosa (Piper) I.M. Johnst. BRISTLY STICKSEED
Open wooded ridges. Jun-Jul. One historical record for Sierra Valley (JEPS67939, J.G. Lemmon, Jul, 1883, Sierra Valley).

HELIOTROPIUM

Heliotropium curassavicum L. var. ***oculatum*** (A. Heller) Tidestr. SALT HELIOTROPE
Uncommon, moist to dry alakline areas on valley floor. Jul-Aug. Dyson Lane, T22N R15E S13.

HESPEROCHIRON

Hesperochiron californicus (Benth.) S. Wats. CALIFORNIA HESPEROCHIRON
Common, moist meadows and alkaline flats. Apr-Jun. Calpine, T21N R14E S16; Marble Lane, T22N R14E S18; Sugarloaf, T23N R15E S17.

Hesperochiron pumilus (Griseb.) Porter DWARF HESPEROCHIRON
Uncommon, wet meadows. Apr-Jul. One record for the Sierra Valley region (RENO33307, Mrs. C. G. Gulling, #1205, no date, Sierra Valley).

HYDROPHYLLUM Waterleaf

Hydrophyllum alpestre A. Nels. & P.B. Kenn. DWARF WATERLEAF
Common, sagebrush scrub. Apr-Jun. Calpine, T21N R14E S16; Beckwourth Sattley Road, T21N R14E S4; Antelope Valley, T21N R15E S28 [= *Hydrophyllum capitatum* var. *alpinum*].

Hydrophyllum occidentale (S. Wats.) A. Gray CALIFORNIA WATERLEAF
Common, moist shaded areas. Apr-Aug. Yuba Pass, T20N R13E S11; Hwy 49 (W of Sattley), T21N R14E S31.

LAPPULA

Lappula redowskii (Hornem.) Greene var. ***redowskii*** WESTERN STICKSEED
Uncommon, disturbed area along the road. Jun-Jul. Hwy 49, T22N R16E S8.

LITHOSPERMUM Puccoon

Lithospermum arvense L. GROMWELL
Disturbed areas. Apr-Jun. One record for Sierra Valley (SJSU9801, C.W. Sharsmith, #8651, May 29, 1982). Sierraville, T20N R14E S13.

Lithospermum ruderale Lehm. WESTERN PUCCOON
Rather common, dry slopes. May-Jun. Newman Point, T21N R14E S25; Ramelli Ranch, T23N R14E S27.

MERTENSIA Lungwort

Mertensia oblongifolia (Nutt.) G. Don var. ***nevadensis*** (A. Nels.) L.O. Williams SAGEBRUSH BLUEBELLS
Infrequent, rocky slopes in sagebrush. Apr-Jun. Little Last Chance Creek, T23N R16E S4; Lemmon Canyon (Sierraville), T20N R15E S23.

MYOSOTIS Scorpion Grass

Myosotis discolor Pers. YELLOW & BLUE SCORPION GRASS
Common, moist disturbed places. Apr-Jul. Beckwourth, T23N R14E S27; Sattley, T20N R14E S9.

NAMA Purple Mat

Nama aretioides (Hook. & Arn.) Brand var. ***californicum*** (Brand) Jeps. CALIFORNIA PURPLE NAMA
Sandy flats and slopes. May-Jul. One record for Sierra Valley (JEPS25520, R. Bacigalupi & L. Constance, #7131, Jun 15, 1959). Newman Point, T21N R14E S26.

Nama aretioides (Hook. & Arn.) Brand var. ***multiflorum*** (A. Heller) Jeps. GROUND NAMA
Uncommon, sandy flats. Jun-Aug. Beckwourth Pass, T22N R17E S6.

Nama densum Lemmon var. ***densum*** PURPLE MAT
Uncommon, open sandy slopes and flats. May-Jul. Vinton, T23N R16E S28; Hwy 70, T23N R16E S35.

Nama densum Lemmon var. ***parviflorum*** (Greenm.) C.L. Hitchc. FEW FLOWERED PURPLE MAT
Sandy areas. Jun-Aug. Frenchman Lake Road, T23N R16E S25; Vinton Cemetery, T23N R16E S31.

NEMOPHILA

Nemophila maculata Lindl. FIVE-SPOT
Uncommon, moist disturbed area. Probably from wildflower seed mix. May-Jun. Sattley, T21N R14E S30.

Nemophila parviflora Benth. var. ***austiniae*** (Eastw.) Brand AUSTIN'S NEMOPHILA
Moist flats and wooded slopes. May-Jul. Calpine, T21N R14E S20; Sugarloaf, T23N R15E S17.

Nemophila pedunculata Benth. MEADOW NEMOPHILA
Common on slopes and flats. Apr-Jul. Calpine, T21N R14E S29; Knuthson Meadow, T21N R14E S5; Hwy 49 (W of Sattley), T21N R14E S31; Vinton, T23N R16E S35; Beckwourth Peak, T22N R14E S4.

Nemophila spatulata Coville SIERRA NEMOPHILA
Common, open rocky slopes. Apr-Jun. Beckwourth Sattley Road, T21N R14E S3.

PECTOCARYA Combseed

Pectocarya penicillata (Hook. & Arn.) A. DC. NORTHERN COMBSEED
Disturbed roadsides. May-Aug. One collection in the Beckwourth Pass area (JEPS68204, W.L. Jepson, #7770, Aug. 2, 1918). To be looked for as the site description says "sandy hills".

PHACELIA

Phacelia bicolor S. Wats. TWO COLORED PHACELIA
Uncommon, dry sandy or rocky slopes. May-Jun. One record for Sierra Valley (JEPS23855, R. Bacigalupi, L. Constance, #7135, Jun 15, 1959). Newman Point, T21N R14E S26.

Phacelia hastata Lehm. var. ***compacta*** (Brand) Cronq. COMPACT PHACELIA
Rocky ridges and slopes. May-Jul. Vinton, T23N R16E S34.

Phacelia hastata Lehm. var. ***hastata*** SILVERLEAF PHACELIA
Common, meadow edges. May-Jul. Yuba Pass, T20N R13E S11; Ramelli Ranch, T23N R14E S27.

Phacelia heterophylla Pursh var. ***virgata*** (Greene) R.D. Dorn VIRGATE PHACELIA
Fairly common, slopes and open areas. May-Jul. Hwy 49 (W of Sattley), T21N R14E S31; Beckwourth, T23N R14E S18.

Phacelia humilis Torr. & A. Gray var. ***humilis*** LOW PHACELIA
Common, flats and meadow edges. May-Jul. Frenchman Lake Road, T23N R16E S10; Beckwourth, T23N R14E S27; Antelope Valley, T21N R15E S16; Calpine, T21N R14E S16.

Phacelia hydrophylloides A. Gray WATERLEAF PHACELIA
Montane meadows and conifer forests. Jun-Sep. Yuba Pass, T20N R13E S11.

Phacelia linearis (Pursh) Holz. LINEAR-LEAVED PHACELIA
Common, rocky and sandy slopes. May-Jul. Beckwourth Pass, T22N R17E S6; Hwy 49, T21N R16E S5; Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S17.

Phacelia mutabilis Greene CHANGEABLE PHACELIA
Meadow edges and slopes. May-Oct. Yuba Pass, T20N R13E S11; Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

Phacelia procera A. Gray TALL PHACELIA
Montane meadows and conifer forest. Jun-Aug. To be looked for as this taxon has been collected just W of Yuba Pass.

Phacelia ramosissima Lehm. BRANCHING PHACELIA
Uncommon, dry slopes. Jun-Sep. Chilcoot, T23N R16E S35; Antelope Valley, T21N R15E S16; Sugarloaf, T23N R15E S17 [= *P. r.* var. *eremophila*].

PLAGIOBOTHRYS Popcornflower

Plagiobothrys bracteatus (Howell) I.M. Johnst. BRACTED POPCORNFLOWER
Common, wet areas. Apr-Jun. Ramelli Ranch, T22N R14E S27.

Plagiobothrys cognatus (Greene) I.M. Johnst. COGNATE POPCORNFLOWER
Fairly common, moist place in forests and meadows. May-Aug. Sattley, T21N R14E S32; Calpine, T21N R14E S17; Knuthson Meadow, T21N R14E S5; Beckwourth Sattley Road, T22N R14E S14; Ross Meadows, T23N R14E S28.

Plagiobothrys cusickii (Greene) I.M. Johnst. CUSICK'S POPCORNFLOWER
Common, vernal areas. May-Oct. Marble Lane, T22N R14E S13; Sattley, T21N R14E S21.

Plagiobothrys hispidulus (Greene) I.M. Johnst. HARSH POPCORNFLOWER
Common in moist areas. Jun-Aug. Sierraville, T20N R15E S18; Sattley, T21N R14E S29; Ramelli Ranch, T23N R14E S27.

Plagiobothrys kingii (S. Wats.) A. Gray var. ***harknessii*** (Greene) Jeps. KING'S POPCORNFLOWER
Local, open sandy areas in the sagebrush. May-Jun. Beckwourth Pass, T23N R17E S31.

Plagiobothrys mollis (A. Gray) I.M. Johnst. var. ***mollis*** HAIRY POPCORNFLOWER
Common in sub-alkaline vernal areas. Jun-Sep. Marble Lane, T22N R14E S13; Beckwourth, T23N R14E S35; Dyson Lane (S of Hwy 70), T22N R15E S6.

Plagiobothrys reticulatus (Piper) I.M. Johnst. NETTED POPCORNFLOWER
Low sagebrush scrub. May-Jul. One collection, on three sheets, for Sierra Valley (UC1063803, UC1063804 & UC573630; H.S. Yates, Jun 28, 1935), Beckworth Sattley Road (NE of Calpine), T21N R14E S9 or S10.

Plagiobothrys tenellus (Nutt. ex Hook.) A. Gray SLENDER POPCORNFLOWER
Openings in sagebrush and sandy slopes. Apr-Jul. Antelope Valley, T21N R15E S28; Frenchman Lake Road, T23N R16E S25.

Plagiobothrys torreyi (Gray) Gray var. ***diffusus*** I.M. Johnst. DIFFUSE POPCORNFLOWER
Local, sandy openings in sagebrush. May-Jul. Calpine, T21N R14E S16; Frenchman Lake Road, T23N R16E S25.

BRASSICACEAE Mustard Family

ALYSSUM

Alyssum alyssoides (L.) L. SMALL ALYSSUM
Rare. Disturbed areas. May-Jul. One record for Sierra Valley (UCD103888, A.M. Shapiro, s.n.). Sierraville, T20N R14E S11.

ARMORACIA

Armoracia rusticana P. Gaertn. et al. HORSE RADISH
Roadsides and old homesites. May-Jul. Calpine, T21N R14E S17; Sierraville, T20N R15E S7.

ATHYSANUS

Athysanus pusillus (Hook.) Greene DWARF ATHYSANUS
Open grassy areas in the sagebrush. Apr-Jun. Sattley, T21N R14E S28; Sierraville, T20N R15E S19.

BARBAREA Winter Cress

Barbarea orthoceras Ledeb. AMERICAN WINTER CRESS
Common, stream banks and other moist places. Apr-Jul. Calpine, T21N R14E S20; Sugarloaf, T23N R15E S17.

BOECHERA Rockcress

Boechera howellii (S. Wats.) Windham & Al-Shehbaz HOWELL'S ROCKCRESS
Rare, rocky subalpine slopes. May-Aug. Coburn Lake, T20N R14E S29 [= *Arabis platysperma* var. *howellii*].

Boechera pinetorum (Tidestr.) Windham & Al-Shehbaz WOODLAND ROCKCRESS
Infrequent, rocky slopes. Apr-Jun. Sattley, T21N R14E S31; Mapes Canyon, T23N R14E S11 [= *Arabis holboellii* var. *p.*].

Boechera puberula (Nutt.) Dorn SILVER ROCKCRESS
Open rocky slopes and volcanic scalds. May-Jul. Mapes Canyon, T23N R14E S11; The Buttes (Hwy 70), T23N R15E S28; Newman Point, T21N R14E S25 [= *Arabis p.*].

Boechera rectissima (Greene) Al-Shehbaz BRISTLY-LEAF ROCK CRESS
Dry granitic slopes and flats. Apr-Jun. Sattley, T20N R14E S4 & S31 [= *Arabis r.*].

Boechera retrofracta (Graham) A. Love. SECUND ROCK CRESS
Dry rocky slopes and flats. Apr-Jul. Newman Point, T21N R14E S25; Sattley, T21 R14E S30; Calpine, T21N R14E S20 [= *Arabis holboellii* var. *r.*].

Boechera sparsiflora Nutt. ELEGANT ROCK CRESS
Dry rocky slopes. Apr-Jun. Sugarloaf, T23N R15E S17; Loyalton, T21N R16E S8 [= *Arabis s.*].

Boechera subpinnatifida (S. Wats.) Al-Shehbaz KALMATH ROCKCRESS
Rocky outcrops and boulder fields. Apr-Jun. Two records for Sierra Valley simply stating "East of Beckwourth". The probable locality would be "The Buttes", T23N R15E S28 [= *Arabis s.*].

Boechera suffrutescens (S. Wats.) Dorn WOODY ROCKCRESS
Rocky slopes. Jun-Aug. To be looked for in the Yuba Pass area as this taxon has been report just to the W [= *Arabis s.*].

BRASSICA Mustard

Brassica rapa L. FIELD MUSTARD
Disturbed areas. May-Jul. One record for Sierra Valley (CAS79732, A. Eastwood, #7803, Jun 29, 1918). Loyalton, T21N R15E S13.

CAMELINA False-Flax

Camelina microcarpa Andrz. SMALL-FRUITED FALSE FLAX
Uncommon, disturbed areas and roadsides. May-Jul. Frenchman Lake Road, T23N R16E S30; Hwy 49, T22N R16E S4; Vinton Cemetery, T23N R16E S35; Sierraville, T20N R15E S7.

CAPSELLA Sheperd's Purse

Capsella bursa-pastoris (L.) Medik. SHEPARD'S PURSE
Common, disturbed sites and waste places. Apr-Jul. Dyson Lane (A-24), T22N R15E S6; Heriot Lane, T21N R15E S9; Calpine, T21N R14E S16.

CARDAMINE Bitter Cress

Cardamine breweri S. Wats. BREWER'S BITTER CRESS
Fairly common, moist shaded areas. Jun-Aug. Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11.

CAULANTHUS Jewelflower

Caulanthus major (M.E. Jones) Payson SLENDER WILD CABBAGE
Dry rocky slopes. May-Jul. To be looked for in the higher elevations of the E side of Sierra Valley. This taxon has been collected to the N of Sierra Valley.

CHORISPORA

Chorispora tenella (Pall.) DC. SLENDER CHORISPORA
Common, cultivated fields and disturbed places. May-Jul. Calpine, T21N R14E S20; Mapes Canyon, T23N R14E S14; Ross Meadows, T23N R14E S27; Sugarloaf, T23N R15E S17.

CUSICKIELLA

Cusickiella douglasii (A. Gray) Rollins DOUGLAS'S CUSICKIELLA
Locally frequent, volcanic scalds and clay flats. Apr-Jun. Calpine, T21N R14E S21; Beckwourth Peak, T22N R14E S9.

DESCURAINIA Tansy Mustard

Descurainia californica (A.Gray) O.E. Schulz SIERRA TANSY MUSTARD
Sagebrush scrub, open woodland and aspen groves. May-Aug. To be looked for on the E side of Sierra Valley.

Descurainia incana (Fisch. & C.A. Mey.) Dorn. MOUNTAIN TANSY MUSTARD
Common, dry slopes and disturbed areas. May-Aug. Ramelli Ranch, T23N R14E S27; Yuba Pass, T20N R13E S11.

Descurainia incisa (Engelm.) Britton subsp. ***incisa*** SHORT-PEDICLED TANSY MUSTARD
Sagebrush scrub. Jun-Aug. Beckwourth Sattley Road, T22N R14E S23.

Descurainia longipedicellata (E. Fourn.) O.E. Schulz LONG-PEDICLED TANSY MUSTARD
Uncommon, dry slopes and sandy areas. May-Jun. Sattley, T20N R14E S9; Hwy 70, T23N R15E S35; Sierraville, T20N R15E S19.

Descurainia pinnata (Walt.) Britton subsp. ***brachycarpa*** (Richardson) Detling WESTERN TANSY MUSTARD
Fairly common, dry sandy soils and slopes. Mar-Jul. Sattley, T20N R14E S9.

Descurainia pinnata (Walt.) Britton subsp. ***glabra*** (Woot. & Standl.) Detling YELLOW TANSY MUSTARD
Common, sandy areas and floodplains. Apr-Jun. Ramelli Ranch, T23N R14E S27.

Descurainia pinnata (Walt.) Britton subsp. ***halictorum*** (Cockerell) Detling WESTERN TANSY MUSTARD
Common, disturbed areas, open sandy slopes. Apr-Jun. Ramelli Ranch, T23N R14E S27; Chilcoot, T23N R16E S36.

Descurainia pinnata (Walt.) Britton subsp. ***intermedia*** (Rydb.) Detling INTERMEADIATE WESTERN TANSY MUSTARD
Dry meadows and sandy areas in sagebrush. May-Jul. Beckwourth Pass, T22N R174 S6.

Descurainia sophia (L.) Webb. ex Prantl TANSY MUSTARD
Uncommon, sandy waste areas. Apr-Jul. Hwy 49, T22N R16E S4; Loyalton, T21N R16E S7; Sugarloaf, T23N R15E S17.

DRABA

Draba verna L. SPRING WHITLOW-GRASS
Common, rocky slopes and disturbed areas. Mar-May. Calpine, T21N R14E S16; Sattley, T21N R14E S32; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

ERYSIMUM

Erysimum capitatum (Hook.) Greene var. ***capitatum*** WESTERN WALLFLOWER
Common, sandy slopes and rocky areas. Mar-Jul. Antelope Valley, T21N R15E S16; Yuba Pass, T20N R13E S11.

Erysimum perenne (Coville) Abrams SIERRA WALLFLOWER
Granitic soils, montane forests. Jun-Aug. Coburn Lake, T20N R13E S36; Yuba Pass, T20N R13E S11.

HESPERIS Rocket

Hesperis matronalis L. DAME'S ROCKET
Apparent garden escapee in roadside ditch. Apr-Jul. Sierraville, T20N R14E S13.

HORNUNGIA

Hornungia procumbens (L.) Hayek LOW HUTCHINSIA
Limited, drying roadside ditch margins. May-Jun. Hwy 49 at Dyson Lane, T22N R16E S17; Marble Lane, T22N R14E S13 [= *Hutchinsia p.*].

IDAHOA

Idahoa scapigera (Hook.) A. Nels. & J.F. Macbr. FLAT-POD
Locally frequent, brush, rocks and open sandy areas. Mar-Apr. Beckwourth Pass, T22N R17E S7; Beckwourth Sattley Road, T22N R14E S34; Antelope Valley, T21N R15E S28.

ISATIS

Isatis tinctoria L. WOAD
Uncommon, disturbed areas. May-Jun. Sierraville, T20N R15E S6; Loyalton, T21N R15E S14.

LEPIDIUM Pepper-Grass

Lepidium acutidens (A. Gray) Howell ALKALI PEPPER-GRASS
Uncommon, alkaline flats. Apr-Jun. Marble Lane, T22N R15E S18 [= *Lepidium dictyotum* var. *a.*].

Lepidium appelianum Al-Shehbaz HAIRY WHITE TOP
Scattered colonies, disturbed areas and waste places. Apr-Aug. Hwy 49, T22N R16E S4; Vinton, T23N R16E S34; Loyalton, T21N R15E S14 [= *Cardaria pubescens*].

Lepidium campestre (L.) W.T. Aiton ENGLISH PEPPER GRASS
Fairly common, meadow edges and disturbed areas. May-Jul. Sugarloaf, T23N R15E S17; Sierraville, T20N R15E S19; Ramelli Ranch, T23N R14E S27.

Lepidium chalepense L. LENS-PODDED HOARY CRESS
Disturbed areas, fields, pastures and riverbanks. May-Jun. Beckwourth Sattley Road, T22N R14E S14.

Lepidium densiflorum Schrad. COMMON PEPPER GRASS
Meadows and disturbed sites. May-Jul. One record for Sierra Valley (JEPS100355, Dean Wm. Taylor, #17823, Jun 28, 2001). Snow Lake (N of Chilcoot), T23N R17E S6.

Lepidium dictyotum A. Gray ALKALI PEPPERWEED
Limited, subalkaline flats. Apr-Jun. Marble Lane, T22N R14E S13.

Lepidium draba L. HEART-PODDED HOARY CRESS
Uncommon, disturbed areas and old fields. Apr-Aug. Ramelli Ranch, T23N R14E S27 [*Cardaria d.*].

Lepidium latifolium L. BROADLEAF PEPPER-GRASS
Uncommon, old fields and roadsides. Jun-Aug. Dyson Lane, T22N R15E S16; Vinton, T22N R16E S8; Beckwourth Sattley Road, T21N R14E S28.

Lepidium perfoliatum L. ROUND-LEAF PEPPER-GRASS
Common, disturbed areas and edges of roads. Apr-Jul. Hwy 49, T22N R16E S8; Marble Lane, T22N R14E S22; Sierraville, T20N R15E S17; Loyalton, T21N R16E S13; Sugarloaf, T23N R15E S17.

Lepidium virginicum L. subsp. ***menziesii*** (DC.) Thell. WILD PEPPER-GRASS
Common, waste places and road edges. May-Nov. Dyson Lane, T22N R16E S13; Sugarloaf, T23N R15E S17; Vinton, T23N R16E S34; Calpine, T21N R14E S17.

NASTURTIUM

Nasturtium officinale R. Br. WATER-CRESS
Common, slow moving water in ditches and streams. Apr-Nov. Sattley, T20N R14E S9; Sugarloaf, T23N R15E S19 [= *Rorippa nasturtium-aquaticum*].

PHOENICAULIS

Phoenicaulis cheiranthoides Nutt. COMMON PHOENCAULIS
Common, open rocky slopes. Apr-Jun. Newman Point, T21N R14E S25; Beckwourth Sattley Road, T22N R14E S26; Harding Point, T20N R15E S6; Sugarloaf, T23N R15E S17.

POLYCTENIUM

Polyctenium fremontii (S. Wats.) Greene FREMONT'S POLYCTENIUM
One record for Sierra Valley (RENO38376, W. Harnach, #1296, 26-Mar-2012). Open flats and dried swales. May-Jun. Hwy 49, between Sierraville and Loyalton, T21N R15E S18.

RAPHANUS Radish

Raphanus sativus L. RADISH
Accidental garden escapee. Uncommon. May-Jul. One record for Sierra Valley (CAS886051, J.T. Howell, Beckworth, #36925, Sep. 24, 1961). Beckwourth, T23N R14E S26.

RORIPPA

Rorippa austriaca (Crantz) Besser AUSTRIAN FIELD CRESS
Uncommon, disturbed soils on roadsides. May-Jul. Sierraville, T20N R15E S7.

Rorippa curvipes Greene BLUNTLEAF YELLOW CRESS
Uncommon, seepage areas and meadows. May-Sep. Sugarloaf, T23N R15E S17.

Rorippa curvisiliqua (Hook.) Britton CURVE-FRUITED YELLOW CRESS
Common, moist to wet places. Apr-Oct. Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S16.

Rorippa palustris (L.) Besser var. ***palustris*** MARSH YELLOW CRESS
Uncommon, drying roadside ditches. Jun-Sep. Dyson Lane, T22N R16E S16.

SINAPIS Charlock

Sinapis arvensis L. CHARLOCK
Disturbed areas. Apr-Sep. One record for Sierra Valley (CAS575418, J.T. Howell, #37815, Jun 18, 1962, 5 mi S of Beckwourth). Probably at the corner of Beckwourth Sattley Road and Marble Lane. T22N R14E S13.

SISYMBRIUM

Sisymbrium altissimum L. TUMBLE MUSTARD
Common, waste places and roadsides. May-Jul. Ramelli Ranch, T23N R14E S28; Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16.

STANLEYA Prince's Plume

Stanleya viridiflora Nutt. PRINCES PLUME
Clay flats. CRPR 2B. May-Jul. One collection of this taxon in Sierra Valley. This site has apparently been destroyed (UCD13371, A.M. Shapiro, s.n., Jul 24, 1996). Dyson Lane (W of Hwy 49), T22N R16E S13.

STREPTANTHUS

No known collections. To be looked for in rocky dry areas in mid summer. *Streptanthus cordatus* var. *cordatus* has been collected at the top of the Bald Mtn. Range which is less than ¼ mi E of the project boundary.

SUBULARIA Awlwort

Subularia aquatica L. subsp. ***americana*** G.A. Mulligan & Calder WATER AWLWORT
Lake margins and sedge meadows. CRPR 4. Jul-Oct. To be looked for in the Coburn Lake area.

THELYPODIUM

Thelypodium brachycarpum Torr. SHORT-PODDED THELYPODIUM
Alkaline and sandy soils. Apr-Aug. One record for Sierra Valley (SJSU12154, N.A. Hopkins, #454, Jun 13, 1972, c. 3 mi NNW of Loyalton). Loyalton, T21N R16E S5.

Thelypodium crispum Payson CRISPED THELYPODIUM
Scattered, sandy areas and alkaline flats. Jun-Jul. Dyson Lane, T22N R16E S17; Hwy 70, T23N R15E S35; Loyalton, T21N R16E S18.

Thelypodium milleflorum A. Nels. MANY-FLOWERED THELYPODIUM
Sandy areas. CRPR 2B. Jun-Aug. May have been collected in Sierra Valley by J.G. Lemmon in 1875 [= *T. laciniatum* var. *m.*].

THLASPI Penny Cress

Thlaspi arvense L. FIELD PENNY-CRESS
Common, waste places and disturbed areas. May-Jul. Marble Lane, T22N R14E S17; Heriot Lane, T21N R15E S9; Loyalton, T21N R15E S12; Antelope Valley, T21N R15E S17, Ramelli Ranch, T23N R14E S27.

THYSANOCARPUS Fringe Pod

Thysanocarpus curvipes Hook. subsp. ***curvipes*** HAIRY FRINGE POD
Scattered, brushy slopes, often in burn areas. Apr-Jun. Mapes Canyon, T23N R14E S11.

TURRITIS Tower Mustard

Turritis glabra L. TOWER ROCKCRESS
Open fields and meadows. Apr-Jul. One record for Sierra Valley (CAS80776, Alice Eastwood, #7824, Jun 29, 1918). Loyalton, T21N R15E S13).

CAMPANULACEAE Bellflower Family

DOWNINGIA

Downingia bacigalupii Weiler BACH'S DOWNINGIA
Common, drying roadside ditches, stream beds and vernal pools. May-Sep. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Downingia bicornuta A. Gray var. ***bicornuta*** TWO-HORNED DOWNINGIA
Common, drying vernal pools and roadside ditches. Apr-Jul. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

Downingia elegans (Douglas ex Lindl.) Torr. ELEGANT DOWNINGIA
I have found 5 records for Sierra Valley but at this time I still have not been able to relocate or confirm the presence of this taxon. If these sheets were to be examined they would all probably be determined as *D. bacigalupii*.

HETROCODON

Hetrocodon rariflorum Nutt. HETROCODON
Damp grassy shaded places, meadow margins and drying stream beds. Apr-Jul. Calpine, T21N R14E S29; Ramelli Ranch, T23N R14E S27.

NEMACLADUS

Nemacladus capillaris Greene COMMON NEMACLADUS
Volcanic outcrops. May-Jul. This taxon has been collected just outside the project area N of Beckwourth.

Nemacladus sigmoideus G.T. Robbins SMALL-FLOWERED NEMACLADUS
Open sandy slopes. May-Jul. Frenchman Lake Road, T23N R16E S11.

PORTERELLA

Porterella carnosula (Hook. & Arn.) Torr. PORTERELLA
Common, roadside ditches and vernal areas. May-Jul. Calpine, T21N R14E S16; Heriot Lane, T22N R15E S21; Marble Lane, T22N R14E S13.

CAPRIFOLIACEAE Honeysuckle Family

LONICERA Honeysuckle

Lonicera conjugialis Kellogg DOUBLE HONEYSUCKLE
Lake shores and wooded slopes. Jun-Jul. Coburn Lake, T20N R13E S29.

Lonicera involucrata (Richardson) Spreng. var. ***involucrata*** TWINBERRY
Moist areas and stream banks. May-Jul. To be looked for as this taxon is common in the higher elevations.

SYMPHORICARPOS Snowberry

Symphoricarpos longiflorus A. Gray FRAGRANT SNOWBERRY
Rocky slopes. May-Jul. Ramelli Ranch, T23N R14E S27.

Symphoricarpos mollis Nutt. CREEPING SNOWBERRY
Common, wooded slopes. Jun-Aug. Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Symphoricarpos rotundifolius A. Gray var. ***rotundifolius*** MOUNTAIN SNOWBERRY
Common, dry open rocky slopes. Jun-Aug. Sattley, T21N R14E S33; Beckwourth Peak, T22N R14E S26; Sugarloaf, T23N R15E S17.

CARYOPHYLLACEAE Pink Family

CERASTIUM Mouse-Ear Chickweed

Cerastium fontanum Baumg. subsp. *vulgare* (Hartm.) Greuter & Burdet COMMON MOUSE-EARED CHICKWEED
Along stream beds. Apr-Aug. Beckwourth Sattley Road, T21N R14E S4; Sugarloaf, T23N R15E S17.

EREMOGONE Sandwort

Eremogone aculeata (S. Wats.) Ikonn. PRICKLY SANDWORT
Common, dry flats and rocky slopes. May-Jul. Antelope Valley, T21N R15E S27; Beckwourth Sattley Road, T22N R14E S23 [= *Arenaria a.*].

Eremogone congesta (Nutt.) Ikonn. var. ***congesta*** BALLHEAD SANDWORT
Common, open rocky slopes. Jun-Aug. Sattley, T20N R14E S4 [= *Arenaria c.* var. *c.*].

Eremogone congesta (Nutt.) Ikonn. var. ***subcongesta*** (S. Wats.) R.L. Hartm. & Rabeler CAPITATE SANDWORT
Common, dry rocky slopes. Jun-Jul. Beckwourth Sattley Road, T22N R14E S11; Antelope Valley, T21N R15E S29; Loyalton, T21N R15E S15 [= *Arenaria c.* var. *s.*].

Eremogone congesta (Nutt.) Ikonn. var. ***suffrutescens*** (A. Gray) R.L. Hartm. & Rabeler
SUFFRUTESCENT SANDWORT
Common, open sandy slopes. Jun-Aug. Ramelli Ranch, T23N R14E S27; Antelope Valley, T21N R15E S27 [= *Arenaria c.* var. *s.*].

Eremogone kingii (S. Wats.) Ikonn. var. ***glabrescens*** (S. Wats.) Dorn KING'S SANDWORT
Common, open rocky slopes. Jun-Jul. Lincoln Ridge, T20N R13E S23 [= *Arenaria k.* var. *g.*].

HOLOSTEUM Chickweed

Holosteum umbellatum L. subsp. *umbellatum* JAGGED CHICKWEED
Uncommon, wet areas of pastures. Apr-Jun. Sattley, T20N R14E S9.

LOEFLINGIA Pygmyleaf

Loeflingia squarrosa Nutt. SPREADING PYGMYLEAF
Disturbed areas. May-Jul. One record for Sierra Valley (CAS881606, J.T. Howell, #37872, Jun 19, 1962, 5.8 mi E of Beckwourth). Hwy 70, T23N R15E S35.

PSEUDOSTELLARIA False Starwort

Pseudostellaria jamesiana (Torr.) W.A. Weber & R.L. Hartm. STICKY STARWORT
Common, moist forest floors and meadow edges. May-Jul. Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11; Antelope Valley, T21N R15E S28.

SAPONARIA Soapwort

Saponaria officinalis L. BOUNCING BET
Uncommon. Disturbed areas on roadsides. Jun-Sep. Marble Lane, T22N R15E S17; Hwy 49 (between Sierraville and Loyalton), T21N R15E S18.

SILENE Catchfly

Silene bernardina S. Wats. PALMER'S CATCHFLY
Fairly frequent, dry rocky slopes and forests. Jun-Aug. Beckwourth Pass, T22N R17E S7. Also found just W of Yuba Pass.

Silene douglasii Hook. var. ***douglasii*** DOUGLAS'S CATCHFLY
Scattered, rocky areas and ridge tops. Jun-Sep. Lincoln Ridge, T20N R13E S23.

Silene invisa C.L. Hitchc. & Maguire SMALL FLOWERED CAMPION
Open forests and montane glades. Jul-Aug. Coburn Lake, T20N R13E S20.

Silene lemmonii S. Wats. LEMMON'S CATCHFLY
Common, dry forest floor. Apr-Aug. Sattley, T20N R14E S4.

Silene nuda (S. Wats.) C.L. Hitchc. & Maguire NAKED CAMPION
Common, sagebrush scrub. May-Jul. Calpine, T21N R14E S16; Marble Lane, T22N R14E S13; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Silene occidentalis S. Wats. WESTERN CAMPION
Conifer forests. Jun-Aug. To be looked for as this taxon has been collected just to the W of Yuba Pass.

Silene verecunda S. Wats. SAN FRANCISCO CAMPION
Open sagebrush scrub. Jun-Jul. One record for Sierra Valley (UCD21015, E. Bortiri, #WFC63, Jul 4, 2002, Knuthson Meadows). Calpine, T21N R14E S5.

SPERGULARIA Sand-Spurrey

Spergularia atrosperma R. Rossbach BLACK-SEEDED SAND-SPURRY
Uncommon, margins of drying ponds and subalkaline flats. Apr-Jun. Marble Lane, T22N R14E S13; Dyson Lane, T22N R16E S17; Calpine, T21N R14E S16; Hwy 70, T23N R15E S35.

Spergularia marina (L.) Griseb. SALT-MARSH SAND-SPURRY
Uncommon, around the hot wells. Apr-Aug. Marble Lane, T22N R14E S13.

Spergularia rubra (L.) J. Presl & C. Presl RED SAND-SPURREY
Open forests and meadows. May-Aug. To be looked for as this taxon has been collected just W of Yuba Pass.

STELLARIA Chickweed

Stellaria longipes Goldie var. ***longipes*** LONG-STALKED CHICKWEED
Common, meadows and other moist places. May-Aug. Sattley, T20N R14E S9; Hwy 49 (between Sattley and Sierraville), T20N R14E S10; Marble Lane, T22N R14E S13; Yuba Pass, T20N R13E S11; Sugarloaf, T23N R15E S17.

Stellaria media (L.) Vill. COMMON CHICKWEED
Moist grassy areas. May-Sep. Beckwourth Sattley Road, T21N R14E S4.

VACCARIA Cow-Herb

Vaccaria hispanica (Mill.) Rauschert COW-HERB
Uncommon. Fields and disturbed areas. May-Aug. Sierraville, T20N R14E S13.

CHENOPODIACEAE Goosefoot Family

ATRIPLEX Saltbrush

Atriplex argenta Nutt. var. ***hillmanii*** M.E. Jones HILLMAN'S SILVER SALTBRUSH
Limited, subalkaline flats. CNPS 2B. Jul-Sep. Marble Lane, T22N R14E S13; Beckwourth (W of The Buttes on Hwy 70), T23N R15E S28.

Atriplex dioica Raf. THICKLEAF ORACH
Subalkaline areas. Jul-Oct. One record for Sierra Valley (CAS919404, Greg & Fred Sommers, #177, Jul 14, 1976). Marble Lane, T22N R14E S13 [= *A. subspicata*].

Atriplex micrantha Ledeb. RUSSIAN SALTBRUSH
Limited, disturbed places. Jul-Sep. Marble Lane, T22N R15E S17.

Atriplex rosea L. TUMBLING ORACH
Local, waste places, road edges and old fields. Jul-Sep. Hwy 49, T22N R16E S4; Beckwourth, T23N R14E S26.

Atriplex truncata (S. Wats.) A. Gray WEDGESCALE
Localized, subalkaline places. Jun-Aug. Marble Lane, T22N R15E S18 & T22N R14E S13; Heriot Lane, T22N R15E S28.

BASSIA

Bassia hyssopifolia (Pall.) Kuntze HYSSOP-LEAVED BASSIA
Limited, moist subalkaline flats. Jul-Oct. Marble Lane, T22N R14E S13 & T22N R15E S18.

CHENOPODIUM Goosefoot

Chenopodium album L. LAMBS-QUARTERS, WHITE GOOSEFOOT
Waste places and disturbed areas. Jun-Oct. Sierraville, T20N R14E S13; Marble Lane, T22N R14E S13.

Chenopodium atrovirens Rydb. DARK-GREEN GOOSEFOOT
Open sagebrush scrub. Jul-Sep. Vinton, T23N R16E S26.

Chenopodium berlandieri Moq. var. ***zschackei*** (Murr) Graebn. PIT SEED GOOSEFOOT
Open disturbed sandy areas. Jul-Aug. Beckwourth, T23N R14E S26; Ramelli Ranch, T23N R14E S27; Heriot Lane, T22N R15E S21.

Chenopodium chenopodiodes (L.) Aellen GOOSEFOOT
Limited, river margins and mudflats. Aug-Sep. Beckwourth, T23N R14E S26.

Chenopodium desiccatum A. Nels. DRY GOOSEFOOT
Common, open dry places and disturbed areas. Jul-Sep. Dyson Lane, T22N R16E S18; Beckwourth Sattley Road (near Beckwourth), T23N R14E S35.

Chenopodium glaucum L. OAK-LEAF GOOSEFOOT
Limited, waste places and road edge. Jul-Aug. Hwy 49 (S of Vinton), T22N R16E S4.

Chenopodium hians Standl. UNKNOWN GOOSEFOOT
Infrequent, dry slopes and flats. Jul-Oct. Hwy 49 (S of Vinton), T22N R16E S4.

Chenopodium strictum Roth var. *glaucophyllum* (Aellen) Wahl GLAUCOUS-LEAVED GOOSEFOOT
Limited, old fields and roadsides. Aug-Oct. Dyson Lane, T22N R15E S13.

KOCHIA

Kochia scoparia (L.) subsp. *scoparia* Schrad. SUMMER-CYPRESS, BURNINGBUSH
Locally frequent, road edges and old fields. Aug-Sep. Vinton, T23N R16E S34.

MONOLEPIS Poverty Weed

Monolepis nuttalliana (Schult.) Greene NUTTALL'S POVERTY WEED
Locally common, roadsides and waste places. Jun-Sep. Heriot Lane, T21N R15E S4; Sierraville, T20N R15E S7.

Monolepis spathulata A. Gray CLUB-LEAF POVERTY WEED
Limited, moist alakline soils. Jun-Sep. Hwy 49 (S of Vinton), T22N R16E S4.

SALSOLA Russian Thistle

Salsola australis R. Br. RUSSIAN THISTLE
Locally frequent, waste places and roadsides. Jun-Oct. Heriot Lane, T22N R15E S21; Sugarloaf, T23N R15E S17.

Salsola paulsenii Litv. BARBWIRE RUSSIAN-THISTLE
Locally frequent, roadsides and waste places. Jul-Sep. Chilcoot, T23N R16E S36; Marble Lane, T22N 15E S18.

Salsola tragus L. RUSSIAN THISTLE, TUMBLEWEED
Fairly frequent in old fields and roadsides. Jul-Oct. Heriot Lane, T22N R15E S21; Beckwourth, T23N R14E S26.

SUAEDA Sea-Blite

Suaeda calceoliformis (Hook.) Moq. HORNED SEA-BLITE
Uncommon, moist sub-alkaline areas. Jul-Sep. Marble Lane, T22N R15E S18.

CONVOLVULACEAE Morning-Glory Family

CALYSTEGIA Morning-Glory
Calystegia malacophylla (Greene) Munz subsp. ***malacophylla*** SIERRA MORNING GLORY
Uncommon, dry slopes. Jun-Aug. Sugarloaf, T23N R25E S17.

Calystegia occidentalis (A. Gray) Brummitt subsp. ***occidentalis*** WESTERN MORNING GLORY
Uncommon. Brushy slopes and open forest floors. May-Aug. Calpine, T21N R14E S20.

Calystegia purpurata (Greene) Brummitt MORNING GLORY
Sagebrush scrub? May-Jun. One record for Sierra Valley (GH369794, H. Mann, Sierraville). Sierraville, T20N R14E S13. This taxon is way out of range.

CONVOLVULUS Bindweed

Convolvulus arvensis L. FIELD BINDWEED
Common, fields, roadsides and disturbed areas. May-Sep. Dyson Lane, T23N R15E S31; Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

CUSCUTA Dodder

Cuscuta californica Hook. & Arn. CALIFORNIA DODDER
Uncommon. Many plants act as host. May-Aug. Hwy 49, T22N R16E S4; Calpine, T21N R14E S20.

Cuscuta occidentalis Millsp. WESTERN DODDER
Uncommon. Many plants act as host. Jun-Aug. Marble Lane, T22N R14E S13; Loyalton, T21N R15E S12.

CORNACEAE Dogwood Family

CORNUS Dogwood

Cornus sericea L. var. ***serica*** STREAMSIDE DOGWOOD, RED WILLOW
Common along streams. Apr-Jun. Sattley, T20N R14E S9; Ramelli Ranch, T23N R14E S27.

CRASSULACEAE Stonecrop Family

CRASSULA Pigmy-Weed

Crassula aquatica (L.) Schönland WATER PIGMY-WEED
Uncommon, vernal pools and swales. Apr-Jul. Marble Lane, T22N R14E S13.

DIPSACACEAE Teasel Family

DIPSACUS Teasel

Dipsacus fullonum L. WILD TEASEL
Uncommon, waste places and disturbed areas. May-Jul. Dyson Lane, T22N R15E S13; Sierraville, T20N R14E S13.

ELATINACEAE Waterwort Family

ELATINE Waterwort
Elatine brachysperma *A. Gray* SHORT SEEDED WATERWORT
Uncommon, receding water of vernal pools. Jun-Oct. Calpine, T21N R14E S16.

Elatine californica A. Gray CALIFORNIA WATERWORT
Uncommon, alkaline flats, mud flats and drying shorelines. May-Jul. Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

Elatine chilensis Gay CHILEAN WATERWORT
Uncommon, muddy shores and ponds. Jun-Jul. Calpine, T21N R14E S16.

Elatine heterandra H. Mason VARIBALE-STAMENED WATERWORT
Uncommon, pond margins. May-Jul. Calpine, T21N R14E S16.

Elatine rubella Rydb. RED WATERWORT
Uncommon, shorelines and ponds. May-Jul. Calpine, T21N R14E S16.

ERICACEAE Heath Family

ALLOTROPA

Allotropa virgata Torr. & A. Gray SUGAR STICK
Scattered at the higher elevations in thick humus. Jun-Aug. Coburn Lake, T20N R13E S29.

ARCTOSTAPHYLOS Manzanita

Arctostaphylos nevadensis A. Gray subsp. ***nevadensis*** PINEMAT MANZANITA
Common, open woody slopes and flats. May-Jul. Coburn Lake, T20N R13E S29; Yuba Pass, T20N R13E S11.

Arctostaphylos patula Greene GREENLEAF MANZANITA
Common, open woods and burns. Feb.-Jun. Calpine, T21N R14E S17; Sattley, T20N R14E S4.

CHIMAPHILA Pipsissewa

Chimaphila menziesii (D. Don) Spreng. LITTLE PRINCES PINE
Common, deep shaded woods. Jun-Aug. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9.

Chimaphila umbellata (L.) W.P.C. Barton WESTERN PRINCES PINE
Common, deep shaded woods. Jun-Aug. Yuba Pass, T20N R13E S11; Calpine, T21N R14E S18.

LEUCOTHOE

Leucothoe davisiae A. Gray SIERRA LAUREL
Moist shaded woods along streams. Jun-Aug. To be looked for as this taxon has been found in the Webber Lake area and to the W of the Calpine area.

ORTHILIA

Orthilia secunda (L.) House ONE-SIDED WINTERGREEN
Scattered, wooded slopes and moist areas. Jul-Sep. To be looked for in the Yuba Pass area as this taxon has been reported just to the west.

PLEURICOSPORA

Pleuricospora fimbriolata A. Gray FRINGED PINE-SAP
Uncommon, deep humus of closed canopy forests. Jun-Aug. Sattley, T21N R14E S31.

PTEROSPORA

Pterospora andromedea Nutt. PINE DROPS
Common. Shaded forest floors. Jun-Aug. Calpine, T21N R14E S17; Sattley, T20N R14E S9.

PYROLA Wintergreen

Pyrola asarifolia Michx. subsp. ***asarifolia*** BOG WINTERGREEN
Uncommon, moist woods and stream edges. Jul-Sep. Sattley, T20N R14E S9.

Pyrola dentata Sm. TOOTHED WINTERGREEN
Fairly common, mixed evergreen forest. Jun-Aug. Yuba Pass, T20N R13E S11.

Pyrola picta Sm. WHITE-VEINED WINTERGREEN
Common, dry forest floors in deep humus. Jun-Aug. Calpine, T21N R14E S16; Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9.

RHODODENDRON

Rhododendron columbianum (Piper) Harmaja LEDUM
Bogs and stream banks. May-Aug. To be looked for in the Coburn lake and Maiden Valley areas [= *Ledum glandulosum*].

SARCODES

Sarcodes sanguinea Torr. SNOW PLANT
Common, deeper humus of forests. May-Jul. Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11; Calpine, T21N R14E S17.

VACCINIUM Blueberry

Vaccinium ulignosom L. subsp. ***occidentale*** (A. Gray) Hulten WESTERN BLUEBERRY
Bogs and wet meadows. Jun-Jul. Yuba Pass, T20N R13E S11.

EUPHORBIACEAE Spurge Family

CHAMAESYCE Prostrate Spurge

Chamaesyce serpyllifolia (Pers.) Small var. ***serpyllifolia*** THYME-LEAVED SPURGE
Common, road edges and other disturbed areas. Aug-Oct. Sattley, T21N R14E S31; Sugarloaf, T23N R15E S17.

CROTON

Croton setigerus Hook. TURKEY MULLEIN
Common, disturbed areas and dry stream beds. Jun-Oct. Calpine, T21N R14E S16 [= *Eremocarpus s.*].

EUPHORBIA Spurge

Euphorbia davidii Subils DAVID'S SPURGE
One specimen collected as a waif from bird seed. Calpine, T21N R14E S17.

FABACEAE Pea Family

ACMISPON Deervetch, Deerweed

Acmispon americanus (Nutt.) Rydb. var. ***americanus*** SPANISH CLOVER
Common, disturbed areas and roadsides. May-Oct. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17 [= *Lotus purshianus* var. *p.*].

Acmispon argophyllus (A. Gray) Brouillet var. ***fremontii*** (A.Gray) Brouillet FREMONT'S SILVER LOTUS
Open slopes. Apr-Jul. Yuba Pass, T20N R13E S11.

Acmispon grandiflorus (Benth.) Brouillet MOUNTAIN CHAPARRAL LOTUS
Pine forests and moist stream bottoms. May-Aug. One record for the Sierra Valley region (RENO4428, Helen Hamlin, s.n., Jul 1904, Sierra Valley). Variety unknown at this point.

Acmispon nevadensis (S. Wats.) Brouillet var. ***nevadensis*** SIERRA NEVADA LOTUS
Fairly common, gravelly slopes and open woods. May-Aug. Calpine, T21N R14E S16 & S20 [*Lotus n.* var. *n.*].

ASTRAGALUS Locoweed

Astragalus andersonii A. Gray ANDERSON'S MILKVETCH
Local, sandy slopes and ridge tops. May-Jul. Dyson Lane, T22N R16E S17; Marble Lane, T22N R15E S18; Lincoln Ridge, T20N R13E S23.

Astragalus canadensis L. var. ***brevidens*** (Gand.) Barneby CANADIAN MILKVETCH
Local, sandy valley floor and road edges. Jun-Jul. Dyson Lane, T22N R16E S17; Chilcoot (Hwy 70), T23N R16E S36; Hwy 49, T22N R16E S4.

Astragalus casei A. Gray CASE'S MILKVETCH
Sandy soils. Apr-Jun. To be looked for in the northeast corner of Sierra Valley. J.G. Lemmon, in his account of the trip to Pyramid Lake with E.L. Case, stated this taxa was "Collected at first near Beckwourth Pass, later on high plateaus of Nevada…"

Astragalus filipes A. Gray THREAD-LEAVED MILKVETCH
Sagebrush slopes. Apr-Jun. To be looked for on the E side of the valley. This taxon has been collected just to the E of Beckwourth Pass.

Astragalus gibbsii Kellogg GIBBS' MILKVETCH
Common, open sandy areas on valley floor. May-Jun. Hwy 49 (at Filippini Road), T21N R15E S8; Hwy 49 (Harding Point), T20N R15E S6.

Astragalus iodanthus S. Wats. var. ***iodanthus*** HUMBOLT RIVER MILKVETCH
Sagebrush slopes. Apr- Jun. Loyalton (Elephant Head), T21N R16E S21; Sugarloaf, T23N R15E S17.

Astragalus lemmonii A. Gray LEMMON'S MILKVETCH
Common, subalkaline meadows. CRPR 1B. May-Sep. Dyson Lane, T22N R16E S17; County Road A-24 (N of Loyalton), T22N R15E S35; Hwy 49, T22N R16E S4, Loyalton, T21N R15E S13; Sugarloaf, T23N R15E S17.

Astragalus lentiformis A. Gray LENS-POD MILKVETCH
Dry sandy slopes and open pine forests. CRPR 1B. May-Jun. One record for Sierra Valley (RSA39363, P.A. Munz, #11817, May 16, 1947, 5 mi N of Chilcoot). Frenchman Lake Road, T23N R16E S11.

Astragalus lentiginosus Douglas var. ***floribundus*** A. Gray FRECKLED MILKVETCH
Open areas in sagebrush. May-Jun. Loyalton, T21N R16E S17.

Astragalus lentiginosus Douglas var. ***lentiginosus*** FRECKLED MILKVETCH
Open areas, sagebrush scrub. May-Jul. Noted by Glenn Clifton at several sites in Sierra Valley but with the notation "These plants may or may not be of this taxon." Ross Ranch, T22N R14E S3; Dyson Lane, T22N R16E S17; Hwy 49, T22N R16E S4.

Astragalus lentiginosus Douglas var. ***salinus*** (Howell) Barneby SAGEBRUSH MILKVETCH
Sagebrush scrub and sandy soils. May-Jun. Dyson Lane (W of Hwy 49), T22N R16E S17; Dyson Lane, T22N R15E S6; Hwy 70 (at A-24), T23N R15E S30.

Astragalus malacus A. Gray SHAGGY MILKVETCH
Dry rocky soils. Apr-Jun. To be looked for in the northeast corner of Sierra Valley. Collected 1 mi E of Beckwourth Pass (SD107330, Christopher Davidson, #2748, Jun 7, 1975).

Astragalus pulsiferae A. Gray. var. ***pulsiferae*** PULSIFER'S MILKVETCH
Locally frequent, dry sandy granitic slopes. CRPR 1B. May-Aug. Beckwourth Pass, T22N R17E S6; Frenchman Lake Road, T23N R16E S12; Sugarloaf, T23N R15E S21; Snow Lake (N of Chilcoot), T23N R17E S6.

Astragalus purshii Douglas var. ***purshii*** PURSHS' WOLLY POD
Locally common, valley floor and slopes. Apr-Jun. Frenchman Lake Road, T23N R16E S25; Sierraville, T20N R14E S24.

Astragalus purshii Douglas var. ***tinctus*** M.E. Jones PURSHS' PURPLE-FLOWERED WOOLY POD
Locally common, rocky to sandy slopes. May-Jun. Beckwourth Pass, T22N R17E S6; Beckwourth, T23N R14E S26; Beckwourth Sattley Road, T22N R14E S2.

Astragalus webberii A. Gray WEBBER'S MILKVETCH
Slopes and dry woodlands. May-Jul. Said to have been collected in Sierra Valley but has never been relocated. There are specimens with labels that say "Indian and Sierra Valleys."

CYTISUS

Cytisus scoparius (L.) Link SCOTCH BROOM
Disturbed sites. May-Aug. One lone plant in Sierraville (Randolph Hill), T20N R14E S13. This plant may be extirpated as this site has been converted to a horse pasture.

HOSACKIA Lotus

Hosackia crassifolia Benth. var. ***crassifolia*** BROAD LEAVED LOTUS
Scattered, dry wooded slopes. May-Aug. Doe Canyon (Seast of Loyalton), T21N R16E S29; Calpine, T21N R13E S24 & S20 [= *Lotus c.* var. *c.*].

Hosackia oblongifolia Benth. var. ***oblongifolia*** NARROW LEAVED LOTUS
Uncommon, wet meadows and seep areas. May-Sep. Sattley, T20N R14E S9 [= *Lotus o.* var. *o.*].

LATHYRUS Wild Pea

Lathyrus brownii Eastw. BROWN'S PEA
Scattered, dry slopes in open woods. Apr-Jun. Beckwourth Sattley Road, T22N R14E S2; Antelope Valley, T21N R15E S28; Calpine, T21N R14E S20; Sattley, T21N R14E S33.

Lathyrus lanszwertii Kellogg var. ***lanszwertii*** NEVADA PEA
Common, open dry slopes. May-Jul. Bear Valley Road (Loyalton), T21N R16E S32; Vinton, T23N R16E S35; Sugarloaf, T23N R15E S17.

Lathyrus latifolius L. SWEET PEA
Scattered, disturbed areas and roadsides. Jun-Sep. Hwy 49 (between Sierraville and Sattley), T20N R14E S10.

Lathyrus nevadensis S. Wats. var. ***nevadensis*** SIERRA NEVADA PEA
Scattered, open dry slopes. Apr-Jun. Calpine, T21N R14E S16.

LOTUS

Lotus corniculatus L. BIRDS-FOOT TREFOIL
Scattered, irrigated pasture lands. Jun-Sep. Dyson Lane, T22N R16E S18; Sierraville, T20N R14E S7.

LUPINUS Lupine

Lupinus albicaulis Douglas WHITE STEMMED LUPINE
Frequent. Openings in pine forests. May-Aug. Calpine, T21N R14E S17; Yuba Pass, T20N R13E S24.

Lupinus andersonii S. Wats. ANDERSON'S LUPINE
Fairly common above 5000ft on dry granitic slopes. May-Aug. Yuba Pass, T20N R13E S14; Hwy 49 (W of Sattley), T20N R13E S1.

Lupinus apertus A.A. Heller SUMMIT LUPINE
Dry, rocky slopes. Jun-Jul. To be looked for in the higher elevations as this taxon is found just to the W at Haskell Peak.

Lupinus arbustus Douglas SPURRED LUPINE
Common. Openings in sagebrush. May-Sep. Calpine, T21N R14E S16; Antelope Valley, T21N R15E S27.

Lupinus argenteus Pursh var. ***heteranthus*** (S. Wats.) Barneby SILVER SPURRED LUPINE
Open slopes and sagebrush scrub. May-Sep. Newman Point, T21N R14E S25; Vinton, T23N R16E S28; Sattley, T21N R14E S31; Yuba Pass, T20N R14E S11; Sugarloaf, T23N R15E S17.

Lupinus argenteus Pursh var. ***meionanthus*** (A. Gray) Barneby MANY FLOWERED LUPINE
Uncommon, brushy slopes. Jul-Aug. Sattley, T20N R14E S16; Calpine, T21N R14E S17.

Lupinus argenteus Pursh var. ***palmeri*** (S. Wats.) Barneby PALMER'S LUPINE
Uncommon. Sagebrush flats. Jul-Aug. Ramelli Ranch, T23N R14E S27.

Lupinus bicolor Lindl. ANNUAL LUPINE
Uncommon. Disturbed soils on road edge. May-Jul. Beckworth Sattley Road, T21N R14E S9.

Lupinus breweri A. Gray var. ***breweri*** BREWER'S LUPINE
Scattered. Open granitic soils. May-Jul. Hwy 49 (W of Sattley), T21N R14E S31; Yuba Pass, T20N R13E S13.

Lupinus grayi S. Wats. GRAY'S LUPINE
Uncommon. Dry open slopes. Jun-Aug. Yuba Pass, T20N R13E S11.

Lupinus latifolius J. Agardh var. ***columbianus*** (A. Heller) C.P. Sm. BROAD LEAVED LUPINE
Common. Meadows and open woods. May-Sep. Hwy 49 (W of Sattley), T21N R14E S31; Sierraville, T20N R14E S13.

Lupinus lepidus Lindl. var. ***confertus*** (Kellogg) C.P. Sm. LEAFY PRAIRIE LUPINE
Sagebrush scrub and dry meadows. Jun-Aug. Lemmon Canyon, T20N R15E S17; Sierraville, T20N R14E S13; Calpine, T21N R14E S20.

Lupinus lepidus Lindl. var. ***sellulus*** (Kellogg) Barneby PRAIRIE LUPINE
Common. Sagebrush flats and sandy areas. Jun-Sep. Hwy 49 (N of Sierraville), T21N R14E S24; Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Lupinus polyphyllus Lindl. var. ***burkei*** (S. Wats.) C.L. Hitchc. BURKE'S MEADOW LUPINE
Fairly common. Stream edges and springs. May-Jul. Sattley, T21N R14E S33; Hwy 49 (S of Sattley), T20N R14E S10; Coburn Lake, T20N R14E S29; Yuba Pass, T20N R13E S11.

MEDICAGO Alfalfa, Medick

Medicago lupulina L. BLACK MEDICK
Uncommon, occasional in old fields. Apr-Jul. Sugarloaf, T23N R15E S17.

Medicago polymorpha L. BUR-CLOVER
Common, disturbed places and old home sites. Apr-Jul. Loyalton, T21N R15E S13.

Medicago sativa L. ALFALFA
Common on roadsides. Apr-Oct. Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16.

MELILOTUS Sweet-Clover

Melilotus albus Medik. WHITE SWEET-CLOVER
Common, roadsides and disturbed areas. May-Sep. Newman Point, T21N R14E S25.

Melilotus officinalis Lam. YELLOW SWEET-CLOVER
Common, roadsides and disturbed areas. May-Aug. Hwy 49 (Sierraville to Loyalton), T20N R14E S7.

ONOBRYCHIS

Onobrychis viciifolia Scop. SANFOIN, HOLY CLOVER
Uncommon, disturbed roadside. Jun. County Road A-24 (N of Loyalton), T22N R15E S36; Loyalton, T21N R15E S12.

ROBINIA

Robinia pseudoacacia L. LOCUST TREE
Common, in towns and old home sites. May-Jun. Sattley, T20N R14E S4.

TRIFOLIUM Clover

Trifolium andersonii A. Gray var. ***andersonii*** ANDERSON'S CLOVER
Locally common, openings in sagebrush. CRPR 4. May-Jun. Calpine, T21N R14E S16; Beckwourth Sattley Road, T22N R14E S11; Loyalton, T21N R16E S30; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Trifolium beckwithii S. Wats. BECKWITH'S CLOVER
Common, meadows and stream beds. May-Jul. Calpine, T21N R14E S16; Marble Lane, T22N R15E S18; Beckwourth Sattley Road, T21N R14E S9; Sattley, T21N R14E S33.

Trifolium breweri S. Wats. BREWER'S CLOVER
Dry forests. May-Aug. One collection listed for Sierra Valley (JEPS65783, J.G. Lemmon, Sierra Valley, "ca. 1878").

Trifolium cyathiferum Lindl. BOWL CLOVER
Common, meadows, seeps and vernal areas. May-Aug. Antelope Valley, T21N R15E S28; Yuba Pass, T20N R13E S14; Calpine, T21N R14E S29.

Trifolium fragiferum L. STRAWBERRY CLOVER
Uncommon, edges of wet meadows. May-Jun. Marble Lane, T22N R15E S18.

Trifolium hirtum All. ROSE or WEEDY CLOVER
Uncommon, roads and waste places. May-Jun. Calpine, T21N R14E S17; Sattley, T21N R14E S33.

Trifolium hybridum L. ALSIKE CLOVER
Scattered, pastures and moist places. Jun-Sep. Calpine, T21N R14E S17; Sattley, T20N R14E S9.

Trifolium lemmonii S. Wats. LEMMON'S CLOVER
Uncommon, wooded flats and volcanic scalds. CRPR 4. May-Jul. Calpine, T21N R14E S29 & S17; Beckwourth Sattley Road, T22N R14E S23; Antelope Valley, T21N R15E S28; Sattley, T21N R14E S32; Beckwourth Sattley Road (Westside Cemetery area), T22N R14E S23; Sugarloaf, T23N R15E S17.

Trifolium longipes Nutt. subsp. ***hansenii*** (Greene) J.M. Gillett MOUNTAIN LONG-STALKED CLOVER
Common, moist areas and shaded woods. May-Sep. Yuba Pass, T20N R13E S11; Correco Canyon, T22N R16E S27; Vinton, T23N R16E S23.

Trifolium longipes Nutt. subsp. ***shastense*** (House) J.M. Gillett. SHASTA CLOVER
Uncommon, red fir forest. Jun-Jul. Yuba Pass, T20N R14E S11.

Trifolium macrocephalum (Pursh) Poir. LARGE-HEADED CLOVER
Common, vernal clay flats. Apr-Jun. Calpine, T21N R14E S16; Marble Lane, T22N R14E S13; Loyalton, T21N R14E S19; Antelope Valley, T21N R15E S28.

Trifolium microcephalum (Pursh) Poir. SMALL HEADED CLOVER
Stream banks and moist disturbed areas. Apr-Aug. Sugarloaf, T23N R15E S17.

Trifolium monanthum A. Gray subsp. ***monanthum*** MOUNTAIN CARPET CLOVER
Montane wet meadows. Jun-Aug. Yuba Pass, T20N R13E S11; Coburn Lake, T20N R14E S29.

Trifolium pratense L. RED CLOVER
Scattered, roadside ditches. May-Sep. Calpine, T21N R14E S17; Marble Lane, T22N R15E S18.

Trifolium productum Greene SHASTA CLOVER
Common, moist flats and stream banks. Jun-Aug. Coburn Lake, T20N R13E S29; Yuba Pass, T20N R13E S11; Calpine, T21N R14E S29.

Trifolium variegatum Nutt. WHITE-TIPPED CLOVER
Fairly common, moist places. Apr-Jul. Yuba Pass, T20N R13E S11; Frenchman Lake Road, T23N R16E S24; Sugarloaf, T23N R15E S17.

Trifolium wormskioldii Lehm. COW CLOVER
Fairly common, moist areas and stream banks. May-Oct. Sattley, T20N R14E S9; Antelope Valley, T21N R15E S28; Calpine, T21N R14E S20.

VICIA Vetch

Vicia americana Willd. subsp. ***americana*** AMERICAN VETCH
Common, roadside ditches. Apr-Jul. Sierraville, T20N R14E S13; Sattley, T21N R14E S29; Ross Meadows, T23N R14E S33; Sugarloaf, T23N R15E S17.

Vicia sativa L. SPRING VETCH
Oak woodlands and disturbed areas. Apr-Jul. Sugarloaf, T23N R15E S17.

Vicia villosa Roth WINTER VETCH
Scattered, roadside ditches. Apr-Jul. Sattley, T20N R14E S4.

FAGACEAE Oak family

CHRYSOLEPIS Chinquapin

Chrysolepis sempervirens (Kellogg) Hjelmq. SIERRA CHINQUAPIN
Scattered, dry rocky slopes. Jul-Aug. Hwy 49 (W of Sattley), T21 R14E S31; Sattley, T20N R14E S9.

QUERCUS Oak

Quercus chrysolepis Liebm. MAUL OAK
Shaded slopes. Apr-May. Antelope Valley, T21N R15E S28.

Quercus kelloggii Newb. BLACK OAK
Scattered stands on slopes. Apr-May. Mapes Canyon, T23N R14E S11; Beckwourth Sattley Road, T22N R14E S34; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S28.

Quercus vacciniifolia Kellogg HUCKLEBERRY OAK
Slopes and rocky areas. May-Jul. One collection for Sierra Valley (UC338540, unknown, Oct. 20, 1890, Oleson's ranch, Sierra Valley, from the Lemmon Herbarium, probably collected by Lemmon). Rebecca Oleson was J.G. Lemmon's sister. Sierraville, T20N R14E S13.

GENTIANACEAE Gentian Family

FRASERA

Frasera albicaulis Griseb. var. ***nitida*** (Benth.) C.L. Hitch. WHITE-STEMMED FRASERA
Scattered, dry open forest floor. May-Jul. Calpine, T21N R14E S29 [*Swertia a.* var. *n.*].

GENTIANA Gentian

Gentiana newberryi A. Gray var. ***tiogana*** (A. Heller) J.S. Pringle ALPINE GENTIAN
Uncommon. Primarily in wet meadows and wet stream beds. Jun-Sep. Calpine, T21N R14E S16; Sattley, T20N R14E S9; Sierraville, T20N R14E S13.

GENTIANOPSIS Fringed Gentian

Gentianopsis simplex (A. Gray) H.H. Iltis ONE-FLOWERED GENTIAN
Scattered, wet meadows and seeps. Jul-Sep. Yuba Pass, T20N R13E S11.

ZELTNERA Centaury

Zeltnera muehlenbergii (Griseb.) G. Mans. JUN CENTAURY
Uncommon, moist places. Jun-Sep. Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S27 [*Centaurium m.*].

GERANIACEAE Geranium Family

ERODIUM Filaree

Erodium cicutarium (L.) Aiton RED-STEMMED FILAREE
Common, disturbed areas and roadsides. Mar-Aug. Calpine, T21N R14E S16; Marble Lane, T22N R14E S13.

GROSSULARIACEAE Gooseberry Family

RIBES Gooseberry

Ribes aureum Pursh var. ***aureum*** GOLDEN CURRANT
Scattered, moist roadside edges. Apr-May. Dyson Lane, T22N 15E S13; Loyalton, T21N R15E S13; Hwy 70, T23N R15E S28; Hwy 49 (S of Vinton), T22N R16E S20.

Ribes cereum Douglas var. ***cereum*** WAX CURRANT
Fairly common, dry rocky slopes and ridges. Jun-Jul. Lincoln Ridge, T20N R13E S23.

Ribes montigenum McClatchie MOUNTAIN CURRANT
Local, open ridges and slopes. Jun-Jul. Coburn Lake, T20N R14E S29.

Ribes nevadense Kellogg SIERRA NEVADA CURRANT
Local. Moist places and along streams. Apr-Jul. Calpine, T21N R14E S29.

Ribes roezlii Regel var. ***roezlii*** SIERRA GOOSEBERRY
Common, open slopes. May-Jul. Sattley, T20N R14E S9; Hwy 49 (S of Vinton), T22N R16E S8.

Ribes velutinum Greene PLATEAU GOOSEBERRY
Dry sandy or rocky slopes. May-Jun. Loyalton, T21N R15E S15; Vinton, T23N R16E S35.

Ribes viscosissimum Pursh STICKY CURRANT
Open forest. May-Jul. To be looked for in the Yuba Pass area as this taxon has been reported just to the W.

HALORAGIDACEAE Water-Milfoil Family

MYRIOPHYLLUM

Myriophyllum sibiricum Kom. SIBERIAN WATER-MILFOIL
Uncommon, drying mud flats. Jun-Sep. Beckwourth Sattley Road, T23N R14E S35.

Myriophyllum spicatum L. EURASIAN WATER-MILFOIL
Common, roadside ditches and drying mud flats. Jul-Sep. Marble Lane, T22N R15E S18.

Myriophyllum verticillatum L. WHORLED WATER-MILFOIL
Common throughout the wetlands. Jul-Sep. Marble Lane, T22N R15E S18.

HYPERICACEAE St. Johns Wort Family

HYPERICUM St. Johns Wort

Hypericum anagalloides Cham. & Schltdl. TINKER'S PENNY
Common, wet meadows streams and seeps. Jun-Aug. Sattley, T20N R14E S4; Yuba Pass, T20N R13E S11.

Hypericum perforatum L. subsp. *perforatum* ST. JOHNS WORT, KLAMATH WEED
Scattered, roadsides and disturbed areas. Jun-Sep. Hwy 49 (between Sattley and Sierraville), T20N R14E S11.

Hypericum scouleri Hook. SCOULERS ST. JOHN'S WORT
Common, wet meadows and streams. Jun-Aug. Sattley, T20N R14E S9; Calpine, T21N R14E S32; Sugarloaf, T23N R15E S17 [*H. formosum* var. *s.*].

LAMIACEAE Mint Family

AGASTACHE Horsemint

Agastache urticifolia (Benth.) Kuntze HORSEMINT
Scattered, moist meadowy slopes and flats. Jun-Sep. Antelope Valley, T21N R15E S16; Loyalton, T21N R16E S13; Frenchman Lake Road, T23N R16E S10.

LAMIUM Dead Nettle

Lamium amplexicaule L. HENBIT
Uncommon, disturbed areas and waste places. Apr-Aug. Loyalton, T21N R15E S12; Beckwourth, T23N R15E S19; Vinton, T23N R16E S19.

MARRUBIUM Horehound

Marrubium vulgare L. COMMON HOREHOUND.
Uncommon, waste places. Apr-Oct. Marble Lane, T22N R15E S18.

MENTHA Mint

Mentha arvensis L. FIELD MINT
Common, wet areas and stream banks. Jul-Sep. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9.

Mentha xpiperita L. PEPPERMINT
Uncommon, marshlands. Jul-Oct. Dyson Lane (S of Hwy 70), T22N R15E S6.

Mentha spicata L. SPEARMINT
Scattered, wet areas. Jul-Sep. Sattley, T20N R14E S9.

MONARDELLA Wild Mint

Monardella odoratissima Benth. subsp. ***glauca*** (Greene) Epling GLAUCOUS MOUNTAIN MINT
Uncommon, dry rocky slopes. Jun-Aug. Loyalton, T21N R16E S29; Frenchman Lake Road, T23N R16E S10.

Monardella odoratissima Benth. subsp. ***pallida*** (A. Heller) Epling MOUNTAIN MINT
Common, dry rocky slopes. Jun-Aug. Sattley, T21N R14E S33; Beckwourth Sattley Road, T22N R14E S34; Calpine, T21N R14E S20.

PRUNELLA

Prunella vulgaris L. var. ***lanceolata*** (W.P.C. Barton) Fernald SELF-HEAL
Common, wet meadows and seeps. May-Sep. Sattley, T21N R14E S9; Calpine, T21N R14E S20.

PYCNANTHEMUM

Pycnanthemum californicum Durand SIERRA MINT
Scattered, moist places. Jun-Nov. Sugarloaf, T23N R15E S17.

SALVIA Sage

Salvia aethiopis L. MEDITERRANEAN SAGE
Uncommon, disturbed areas. Jun-Jul. A weed that should be removed whenever found. Loyalton, T21N R16E S18.

Salvia dorrii (Kellogg) Abrams var. ***dorrii*** DORR'S SAGE
Dry flats and slopes. May-Jul. To be looked for on the E side of the valley as this taxon is found to the east in lower Long Valley (Red Rock Road & Hwy 395 N of Hallelujah Junction).

Salvia dorrii (Kellogg) Abrams var. ***pilosa*** (A. Gray) Strachan & Reveal HAIRY SAGE
Dry slopes and washes. May-Jul. One historic collection at Portola (UC454120, Katharine Brandegee, Jul 30, 1911). To be looked for in weathered volcanic soils.

SCUTELLARIA Skullcap

Scutellaria nana A. Gray DWARF SKULLCAP
Dry volcanic soils. Jun-Aug. To be looked for as this taxon has been reported northwest of Frenchman Lake.

There are two other collections by J.G. Lemmon for this genus listed for Sierra County that may or may not be from Sierra Valley: ***S. antirrhinoides*** Benth., Sep. 1874 [UC1523373] and ***S. siphocampyloides*** Vatke, Aug. 1874 [UC 1523371].

STACHYS Hedge Nettle

Stachys ajugoides Benth. BUGLE HEDGE NETTLE
Common, moist areas and seeps. Jul-Sep. Sattley, T21N R14E S30; Calpine, T21N R14E S20.

TRICHOSTEMA Bluecurls

Trichostema oblongum Benth. MOUNTAIN BLUECURLS
Common, drying stream beds and vernal areas. Jun-Sep. Calpine, T21N R14E S16 & S29; Ramelli Ranch, T23N R14E S27.

Trichostema simulatum Jeps. SISKIYOU BLUECURLS
Common, dry slopes and openings in sagebrush. Jun-Aug. Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S28; Calpine, T21N R14E S16.

LENTIBULARIACEAE Bladderwort Family

UTRICULARIA Bladderwort

Utricularia macrorhiza Leconte COMMON BLADDERWORT
Uncommon, roadside ditches and ponded water. Jun-Sep. Calpine, T21N R14E S16; Marble Lane, T22N R15E S18.

LIMNANTHACEAE False Mermaid Family

FLOERKEA False Mermaid
Floerkea proserpinacoides Willd. FALSE MERMAID
Locally frequent, vernal areas. Apr-Jul. To be looked for as this taxon has been reported just outside the northern boundary of the project area at Dotta Saddle.

LINACEAE Flax Family

HESPEROLINON Dwarf Flax

Hesperolinon micranthum (A. Gray) Small SMALL FLOWERED DWARF FLAX
Open woodland margins. May-Jul. Antelope Valley, T21N R15E S28; Sattley, T20N R14E S4.

LINUM Flax

Linum lewisii Pursh var. ***lewisii*** WESTERN BLUE FLAX
Common, drying open flats and slopes. May-Sep. Hwy 49 (S of Vinton), T22N R16E S17; Calpine, T21N R14E S21; Antelope Valley, T21N R15E S28; Beckwourth Sattley Road, T22N R14E S11; Sugarloaf, T23N R15E S17.

SCLEROLINON

Sclerolinon digynum (A. Gray) C.M. Rogers NORTHWESTERN YELLOW FLAX
Moist meadows. May-Sep. Beckwourth Sattley Road, T21N R14E S3; Knutson Meadows, T21N R14E S6; Dyson Lane (S of Hwy 70), T22N R15E S5.

LOASACEAE Loasa Family

MENTZELIA

Mentzelia albicaulis (Hook.) Torr. & A. Gray WHITE-STEMMED STICK-LEAF
Fairly common, open flats and sandy slopes. May-Jul. Marble Lane, T22N R14E S13; Beckwourth Pass, T22N R17E S6; Loyalton, T21N R15E S12; Sugarloaf, T23N R15E S17.

Mentzelia congesta Torr. & A. Gray VENTANA STICK-LEAF
Common, open sandy places. May-Jul. Frenchman Lake Road, T23N R16E S25; Sugarloaf, T23N R15E S17.

Mentzelia dispersa S. Wats. NADA STICK-LEAF
Fairly common, dry rocky and sandy slopes. Jun-Jul. Hwy 70, T23N R15E S35; Antelope Valley, T21N R15E S28; Ramelli Ranch, T23N R14E S27.

Mentzelia laevicaulis (Hook.) Torr. & A. Gray BLAZING STAR
Uncommon, disturbed road edge. Jul-Aug. Marble Lane, T22N R15E S18.

Mentzelia montana Davidson MOUNTAIN STICK-LEAF
Uncommon, flats among the sagebrush. May-Jul. Beckwourth, T23N R14E S26; Newman Point, T21N R14E S25; Hwy 70 (W of Vinton), T23N R16E S32; Frenchman Lake Road, T23N R16E S5.

Mentzelia veatchiana Kellogg VEATCH'S STICK-LEAF
Locally common, open sandy slopes and flats. May-Jul. Frenchman Lake Road, T23N R16E S25; Ramelli Ranch, T23N R14E S27; Beckwourth Sattley Road, T22N R14E S34.

LYTHRACEAE Loosestrife Family

LYTHRUM Loosestrife

Lythrum hyssopifolia L. HYSSOP LOOSESTRIFE
Uncommon, moist places and river edges. May-Sep. Ramelli Ranch, T23N R14E S27.

Lythrum portula (L.) D.A. Webb. WATER PURSLANE
Uncommon, wet places and drying marshes. Jul-Aug. Marble Lane, T22N 15E S18; Beckwourth Sattley Road (S of Hwy 70), T23N R14E S35.

ROTALA

Rotala ramosior (L.) Koehne TOOTH CUP
Uncommon, wet areas. Jun-Aug. Calpine, T21N R14E S16; Beckwourth Sattley Road (S of Hwy 70), T22N R14E S2.

MALVACEAE Mallow Family

ABUTILON Indian Mallow
Abutilon theophrasti Medik. VELVETLEAF
Isolated garden weed. Apparently came from birdseed. Jul-Aug. Loyalton, T21N R15E S13.

HIBISCUS

Hibicus trionum L. FLOWER-OF-AN-HOUR
Rare. Disturbed areas. Apr-Nov. One record for Sierra Valley (UCD127641, A.M. Shapiro, s.n.). Sierraville, T20N R14E S24.

MALVA Mallow

Malva neglecta Wallr. COMMON MALLOW
Common, disturbed areas. May-Sep. Vinton, T23N R16E S34; Calpine, T21N R14E S16; Loyalton, T21N R15E S13.

SIDALCEA Checker Mallow

Sidalcea glaucescens Greene WAXY CHECKERBLOOM
Open forest and dry meadows. Jun-Aug. To be looked for as this taxon has been collected in areas bordering Sierra Valley.

Sidalcea oregana (Torr. & A. Gray) A. Gray subsp. ***spicata*** (Regel) C.L. Hitchc. SPIKED CHECKERBLOOM
Common, open meadows and stream banks. Jun-Oct. Sattley, T20N R14E S9; Marble Lane, T22N R14E S13; Sierraville, T20N R14E S13; Sugarloaf, T23N R15E S17.

SPHAERALCEA Globemallow

Sphaeralcea munroana (Lindl.) Spach ex A. Gray MUNROE'S CHECKERBLOOM
Rare, probable waif. Jun-Jul. Hwy 70 (W of Vinton), T23N R16E S28; Newman Point, T21N R14E S25.

MENYANTHACEAE Buckbean Family

MENYANTHES

Menyanthes trifoliata L. BOGBEAN
Uncommon, shallow lakes and ponds. Jul. Coburn Lake, T20N R14E S29.

MONTIACEAE Miner's Lettuce Family

CALYPTRIDIUM Pussypaws

Calyptridium monospermum Greene SINGLE-SEEDED PUSSY PAWS
Common, sandy to gravelly areas. Jun-Aug. Calpine, T21N R14E S17; Sattley, T20N R14E S9.

Calyptridium umbellatum (Torr.) Greene PUSSY PAWS
Fairly common, sandy to gravelly areas. May-Nov. Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

CLAYTONIA

Claytonia lanceolata Pursh WESTERN-SPRING BEAUTY
Fairly common, near melting snow banks. Apr-Jul. Calpine, T21N R14E S29.

Claytonia perfoliata Willd. subsp. ***perfoliata*** MINERS LETTUCE
Common in wooded areas. Mar-May. Calpine, T12N R14E S16; Sugarloaf, T23N R15E S17.

Claytonia rubra (Howell) Tidestr. subsp. ***depressa*** (A. Gray) John M. Mill. & K.L. Chambers REDDISH MINERS LETTUCE
Open disturbed areas. Mar-Jun. Calpine, T21N R14E S19.

Claytonia rubra (Howell) Tidestr. subsp. ***rubra*** REDDISH MINERS LETTUCE
Fairly common, roadsides. Mar-May. Hwy 49 (S of Vinton), T22N R16E S8; Calpine, T21N R14E S20.

LEWISIA

Lewisia nevadensis (A. Gray) B.L. Rob. NEVADA LEWISIA
Fairly common, moist areas and meadows. May-Jul. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

Lewisia rediviva Pursh BITTERROOT
Open volcanic soils. May-Jun. To be looked for as this taxon has been collected just outside the project area; north at Dixie Valley and just E of Staverville canyon (Loyalton).

Lewisia triphylla (S. Wats.) B.L. Rob. THREE-LEAVED LEWISIA
Moist gravelly areas and glades. May-Aug. Coburn Lake, T20N R14E S29.

MONTIA

Montia chamissoi (Spreng.) Greene TOAD-LILY
Common in slow moving water of springs and marshes. May-Jul. Sattley, T20N R14E S9; Dyson Lane, T22N R15E S6.

Montia dichotoma (Nutt.) Howell DICHOTOMOUS MONTIA
Limited, vernal areas. May-Jun. Dyson Lane, T22N R16E S17.

Montia fontana L. WATER-CHICKWEED
Rain pools and vernal areas. Apr-Jun. Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R15E S18.

Montia linearis (Hook.) Greene LINEAR-LEAVED MONTIA
Common, moist areas. Apr-Jun. Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S16; Vinton, T23N R16E S35.

MYRSINACEAE

LYSIMACHIA

Lysimachia minima (L.) U. Manns & Anderb. CHAFFWEED
Uncommon. Vernal areas. Apr-Jul. Ramelli Ranch, T23N R14E S27 [*Centunculus m.; Anagallis m.*].

NYCTAGINACEAE Four-O'clock Family

ABRONIA Sand Verbena

Abronia turbinata S. Wats. TRANSMONTANE ABRONIA
Rare, small sand dunes. Jun-Jul. Frenchman Lake Road, T24N R16E S25 (Reported by Glenn Clifton); Sierra Valley (JEPS61228, J.G. Lemmon, Aug 1873).

ONAGRACEAE Evening Primrose Family

CAMISSONIA Sun Cup

Camissonia contorta (Douglas) Kearney CONTORTED SUN CUP
Common, open sandy soils. Apr-Jul. Frenchman Lake Road, T23N R16E S25; Beckwourth, T23N R14E S25; Hwy 70, T23N R15E S30; Calpine, T21N R14E S16.

Camissonia parvula (Torr. & A. Gray) P.H. Raven LEWIS RIVER SUN CUP
Sandy soils, sagebrush scrub. May-Jun. To be looked for as this taxon has been collected just to the E of Beckwourth Pass.

Camissonia pubens (S. Wats.) P.H. Raven CARSON CITY SUN CUP
Uncommon, open sandy soil in sagebrush. Jun-Jul. Dyson Lane (S of Hwy 70), T22N R15E S6; Vinton, T23N R16E S35.

Camissonia pusilla P.H. Raven TINY SUN CUP
Fairly common, dry rocky slopes. May-Jun. Hwy 49 (N of Loyalton), T21N R16E S5; Loyalton, T21N R16E S8; Beckwourth Pass, T23N R17E S6.

CHAMERION Fireweed

Chamerion angustifolium (L.) Holub. subsp. ***circumvagum*** (Mosquin) Hoch FIREWEED.
nfrequent, open or shaded moist slopes. Jul-Sep. Sierraville, T20N R14E S22; Calpine, T21N R14E S19 [= *Epilobium a.* subsp. *c.*].

CIRCAEA

Circaea alpina L. subsp. ***pacifica*** (Asch. & Magnus) P.H. Raven ENCHANTERS NIGHSHADE
Common, moist woods and brushy stream sides. Jun-Aug. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9; Sierraville, T20N R14E S22.

CLARKIA

Clarkia gracilis (Piper) A. Nels. & J.F. Macbr. SLENDER CLARKIA
Uncommon, rocky volcanic slopes. Apr-Jul. One record for Sierra Valley (CAS1100035; J.R. Shevock, B. Ertter #11536, Jun 1, 1986). Newman Point, T21N R14E S26.

Clarkia lassenenis (Eastw.) H. Lewis & M. Lewis LASSEN'S CLARKIA
Common, dry open forest and sagebrush scrub. May-Jul. Calpine, T21N R14E S16; Antelope Valley, T21N R15E S16; Mapes Canyon, T23N R14E S11; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Clarkia rhomboidea Douglas DIAMOND CLARKIA
Common, open forests and rocky areas. May-Jul. Antelope Valley, T21N R15E S16; Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S30.

EPILOBIUM Willow-Herb

Epilobium anagallidifolium Lam. ALPINE WILLOWHERB
Uncommom, moist alpine slopes, stream banks and meadows. Jun-Sep. One record for the Sierra Valley region (JEPS43876, L.S. Smith #2436, 1928). Yuba Pass, T20N R13E S11.

Epilobium brachycarpum C. Presl. PANICLED WILLOWHERB
Common, dry open places and disturbed areas. Jun-Aug. Sattley, T20N R14E S9; Beckwourth, T23N R14E S11; Calpine, T21N R14E S16; Yuba Pass, T20N R13E S11; Sierraville, T20N R14E S13; Sugarloaf, T23N R15E S17.

Epilobium campestre (Jeps.) Hoch & W.L. Wagner SMALL WILLOWHERB
Infrequent, drying vernal and wet areas. May-Sep. Beckwourth Sattley Road, T23N R14E S35; Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S15.

Epilobium canum (Greene) P.H. Raven subsp. ***latifolium*** (Hook.) P.H. Raven CALIFORNIA FUCHSIA
Uncommon. Dry slopes. Jun-Sep. Calpine, T21N R14E S30 (SJSU12100, N.A. Hopkins, C.L. Schmidt, #1119, Aug. 1, 1982); Loyalton, T21N R15E S13 (POM272049, Mrs. J.W. Morrison, s.n.) [= *Zauschneria californica* subsp. *l.*].

Epilobium ciliatum Raf. subsp. ***ciliatum*** CILIATE WILLOWHERB
Common. Meadows, streams and seeps. Jul-Aug. Beckwourth Sattley Road, T21N R14E S21; Sugarloaf, T23N R15E S17.

Epilobium ciliatum Raf. subsp. ***glandulosum*** (Lehm.) Hoch & P.H. Raven GLANDULAR WILLOWHERB
Common, seeps and meadows. Apr-Sep. Sattley, T20N R14E S9.

Epilobium cleistogamum (Curran) Hoch & P.H. Raven SELFING WILLOWHERB
Vernal pools. May-Jul. One collection for the Sierra Valley region (SJSU15150, N.A. Hopkins, C.L. Schmidt, #1734, Jul 23, 1993). Marble Lane, T22N R14E S13. Normally found in the Sacramento Valley vernal pools. Probable misidentification as the difference between this taxon and *E. campestre* is in the seeds.

Epilobium densiflorum (Lindl.) Hoch & P.H. Raven DENSE FLOWERED WILLOWHERB
Common, vernally moist areas. May-Oct. Calpine, T21N R14E S16; Marble Lane, T22N R14E S13; Antelope Valley, T21N R15E S21.

Epilobium glaberrimum Barbey subsp. ***glaberrimum*** GLAUCOUS WILLOWHERB
Common. Seeps, streams and wet meadows. Jun-Aug. Sierraville, T21N R15E S18.

Epilobium hallianum Hausskn. HALL'S WILLOWHERB
Moist meadows. Jun-Sep. To be looked for as this taxon is found just outside the project area at McNair Meadow.

Epilobium hornemannii Rchb. subsp. ***hornemannii*** HORNEMANN'S WILLOWHERB
Fairly common, seeps and streams. Jul-Aug. To be looked for in the higher elevations as this taxon has been reported just to the W of Yuba Pass.

Epilobium howellii Hoch HOWELL'S WILLOWHERB
Rare, mossy seeps and wet meadows. Often overlooked. CRPR 4. Jul-Aug. Yuba Pass, T20N R13E S11; Maiden Valley, T20N R13E S29.

Epilobium minutum Lindl. MINUTE WILLOWHERB
Common, dry, open disturbed areas and vernal pools. May-Aug. To be looked for as this taxon has been found to the N and W of Sierra Valley.

Epilobium oreganum Greene OREGON FIREWEED
Rare. Moist edges of river. CRPR 1B. Jul-Sep. Ramelli Ranch, T23N R14E S28.

Epilobium pallidum (Eastw.) Hoch & P.H. Raven LARGE FLOWERED SPIKE PRIMROSE
Moist sandy or gravelly areas. May-Jul. Calpine, T21N R14E S19.

Epilobium saximontanum Hausskn. ROCKY MOUNTAIN WILLOWHERB
Meadows and stream banks. Jul-Sep. To be looked for in the higher elevations as this taxon has been collected near Webber Lake.

Epilobium torreyi (S. Wats.) Hoch & P.H. Raven TORREY'S WILLOWHERB
Seasonally moist swales and stream banks. May-Aug. Calpine, T21N R14E S15.

GAYOPHYTUM Groundsmoke

Gayophytum diffusum Torr. & A. Gray subsp. ***diffusum*** DIFFUSE GROUNDSMOKE
Common, dry sandy flats and slopes and openings in brush. Jun-Aug. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

Gayophytum diffusum Torr. & A. Gray subsp. ***parviflorum*** H. Lewis & Szweyk. HAIRY-SEEDED GROUNDSMOKE
Common, dry sandy slopes and ridges. Jun-Aug. Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E 30; Beckwourth Sattley Road (S of Beckwourth), T22N R14E S11.

Gayophytum eriospermum Coville COVILLE'S GROUNDSMOKE
Open montane forest. Jul-Aug. Chilcoot, T23N R16E S11.

Gayophytum heterozygum F.H. Lewis & Szweyk. ZIGZAG GROUNDSMOKE
Open rocky and gravelly slopes. Jun-Aug. NE of The Buttes, T23N R15E S11; Sugarloaf, T23N R15E S17.

Gayophytum humile A. Juss. LOW GROUNDSMOKE
Drying margins of wet sites. Jul-Aug. Calpine, T21N R14E S30.

Gayophytum racemosum Torr. & A. Gray BLACK FOOTED GROUNDSMOKE
Drying margins of meadows. Jul-Aug. Calpine, T21N R14E S16.

Gayophytum ramosissimum Torr. & A. Gray MANY-BRANCHED GROUNDSMOKE
Common, sandy flats and dry slopes. Jun-Aug. Frenchman Lake Road, T23N R16E S25; Beckwourth Pass, T22N R17E S6.

NEOHOLMGRENIA

Neoholmgrenia andina (Nutt.) W.L. Wagner & Hoch PLATEAU SUN CUP
Uncommon, vernal flats, often in clay soil. May-Jul. Dyson Lane, T22N R16E S17; Calpine, T21N R14E S21 [= *Camissonia a.*].

OENOTHERA Evening Primrose

Oenothera californica (S. Wats.) S. Wats. subsp. ***avita*** W.M. Klein CALIFORNIA EVENING PRIMROSE

Way out of range but with sagebrush association; probable misidentification (SJSU14291, N.A. Hopkins, S.R. Piazza, #1527, Jun 7, 1989). Need fruit for positive identification. Chilcoot, T23N R16E S11.

Oenothera cespitosa Nutt. subsp. ***marginata*** (Hook. & Arn.) Munz FRAGRANT EVENING PRIMROSE
Limited, openings in sandy areas. May-Jul. Frenchman Lake Road, T23N R16E S30.

Oenothera deltoides Torr. & Frém. subsp. ***piperi*** (Munz) W.M. Klein PIPER'S EVENING PRIMROSE
Common, dry sandy flats and slopes. May-Jul. Beckwourth Pass, T23N R17E S31; Vinton, T23N R15E S35; Frenchman Lake Road, T23N R16E S14.

Oenothera flava (A. Nels.) Garret DANDELION-LIKE EVENING PRIMROSE
Common, vernal areas and margins of drying meadows. May-Jul. Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S27; Hwy 70 (E of Beckwourth), T23N R15E S34.

TARAXIA

Taraxia subacaulis (Pursh) Rydb. NORTHERN SUN CUP
Uncommon, wet to somewhat dry clay meadows. May-Aug. To be looked for as this taxon is found to the N and S of the project area.

Taraxia tanacetifolia (Torr. & A. Gray) Piper SIERRA VALLEY EVENING PRIMROSE
Clay flats and roadsides. May-Jul. Hwy 49 (N of Sierraville), T21N R14E S24; Dyson Lane (S of Hwy 70), T22N R15E S5 [= *Camissonia t.* subsp. *quadriperforata*].

OROBANCHACEAE Broomrape Family

CASTILLEJA Paintbrush

Castilleja applegatei Fernald subsp. ***pinetorum*** (Fernald) Chuang & Heckard WAVY LEAVED PAINTBRUSH
Common, dry rocky slopes and flats. May-Jul. Sattley, T20N R14E S4; Calpine, T21N R14E S18 & S20; Sierraville, T20N R15E S30; Antelope Valley, T21N R15E S28.

Castilleja arachnoidea Greenm. COBWEBBY PAINTBRUSH
Usually above 6000 ft, open rocky slopes and ridges. May-Aug. Snow Lake (N of Chilcoot), T23N R17E S6.

Castilleja campestris (Benth.) Chuang & Heckard subsp. ***campestris*** ANNUAL FIELD PAINTBRUSH
Common in roadside ditches and other vernal areas. Jun-Jul. Heriot Lane, T22N R15E S21 [Orthocarpus c.].

Castilleja chromosa A. Nels. DESERT PAINTBRUSH
Uncommon, dry sagebrush slopes. May-Jul. Beckwourth Pass, T22N R17E S7.

Castilleja lacera (Benth.) Chuang & Heckard ANNUAL CUT LEAVED PAINTBRUSH
Fairly common, roadside ditches. May-Jul. Heriot Lane, T22N R15E S21; Antelope Valley, T21N R15E S28; Calpine, T21N R14E S17; Sattley, T20N R14E S4; Marble Lane, T22N R15E S18.

Castilleja miniata Hook. subsp. ***miniata*** GREAT RED PAINTBRUSH
Common, moist meadows and stream banks. May-Sep. Sattley, T20N R14E S9.

Castilleja nana Eastw. DWARF PAINTBRUSH
Above 6000 feet, open rocky slopes and ridges. Jun-Jul. There area several areas within the Sierra Valley region that are good habitat for this species.

Castilleja pilosa (S. Wats.) Rydb. HAIRY PAINTBRUSH
Fairly common, open dry gravelly slopes, ridges and sagebrush flats. Jun-Jul. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Hwy 49 (S of Vinton), T22N R16E S10; Ramelli Ranch, T23N R14E S27.

Castilleja tenuis (A. Heller) Chuang & Heckard HAIRY ANNUAL PAINTBRUSH
Common, meadows. May-Oct. Heriot Lane, T22N R15E S21; Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27 [*Orthocarpus hispidus*].

CORDYLANTHUS Birds Beak

Cordylanthus ramosus Nutt. ex Benth. MANY BRANCHED BIRDS BEAK
Open brushy slopes. Jul-Sep. To be looked for in the Chilcoot area.

Cordylanthus tenuis A. Gray subsp. ***tenuis*** SLENDER BIRDS BEAK
Fairly common, but not often noted. Open pine forests. Jul-Sep. Calpine, T21N R14E S18; Sierraville, T20N R15E S20.

OROBANCHE Broomrape

Orobanche corymbosa (Rydb.) Ferris RYDBERG'S BROOMRAPE
Common, mostly parasitic on sagebrush. Jun-Aug. Frenchman Lake Road, T23N R16E S25; Hwy 70, T23N R15E S35; Sattley, T21N R14E S31; Sugarloaf, T23N R15E S17.

Orobanche fasciculata Nutt. CLUSTERED BROOMRAPE
Common, mostly parasitic on sagebrush. Apr-Jul. Antelope Valley, T21N R15E S16; Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16.

Orobanche uniflora L. NAKED BROOMRAPE
Common, mostly parasitic on herbs. Apr-Jul. Antelope Valley, T21N R15E S16.

ORTHOCARPUS Owl Clover

Orthocarpus cuspidatus Greene subsp. ***copelandii*** (Piper) Chuang & Heckard COPELAND'S OWL CLOVER
Open slopes and ridges. Jun-Jul. To be looked for in the Yuba Pass area as this taxon has been reported just to the W.

Orthocarpus cuspidatus Greene subsp. ***cryptanthus*** (Piper) Chuang & Heckard SHORT FLOWERED OWL CLOVER
Mostly on volcanic open slopes and ridges. Jun-Jul. To be looked for as it has been found both N and S of project area.

Orthocarpus luteus Nutt. YELLOW OWL CLOVER
Edges of vernal areas in the sagebrush. Jul-Aug. Marble Lane, T22N R15E S18; Hwy 49 (S of Vinton), T22N R16E S4; Beckwourth Sattley Road (N of Sattley), T21N R14E S22; Heriot Lane, T22N R15E S21; Dyson Lane (S of Hwy 70), T22N R15E S5.

PEDICULARIS Lousewort

Pedicularis attollens A. Gray LITTLE ELEPHANTS HEAD
Fairly common, wet meadows, especially in the Sierraville and Sattley areas. Jun-Sep. Sierraville, T20N R14E S13; Sattley, T21N R14E S33.

Pedicularis groenlandica Retz. LARGE ELEPHANTS HEAD
Locally common, very wet meadows and seep areas. Generally above 6000'. Jul-Aug. Yuba Pass, T20N R13E S11.

Pedicularis racemosa Benth. LEAFY LOUSEWORT
Moist areas in open conifer forest. Jun-Aug. To be looked for in the Yuba Pass area.

Pedicularis semibarbata A. Gray PINE LOUSEWORT
Common in shaded woods, generally above 6000'. May-Jul. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9.

PAEONIACEAE Paeony Family

PAEONIA

Paeonia brownii Douglas BROWN'S PAEONY
Common, dry brushy slopes and flats. Apr-Jul. Calpine, T21N R14E S16; Ross Meadows, T23N R14E S34; Sattley, T20N R14E S4; Newman Point, T21N R14E S25; Sugarloaf, T23N R15E S17.

PAPAVERACEAE Poppy Family

ARGEMONE Prickly Poppy

Argemone munita Durand & Hilg. PRICKLY POPPY
Scattered, dry rocky and sandy slopes. Jul-Sep. Sierraville, T20N R15E S17; Hwy 49 (S of Vinton), T22N R16E S4; Sugarloaf, T23N R15E S17.

DICENTRA Bleeding Heart

Dicentra uniflora Kellogg STEERS HEAD
Uncommon, rocky slopes along snow melt line. Mar-Jul. Beckwourth Sattley Road, T22N R14E S34.

ESCHSCHOLZIA Poppy

Eschscholzia californica Cham. CALIFORNIA POPPY
Common, roadsides. May-Jul. Vinton, T23N R16E S28; Sattley, T21N R14E S33; Dyson Lane, T22N R15E S16; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

PHRYMACEAE Monkeyflower

Currently *The Jepson Manual, Second Edition* is maintaining *Mimulus* as the only genus in the Phrymaceae family. Names proposed Barker et al. (2012) in segregate genera are included here as synonyms.

MIMULUS

Mimulus breviflorus Piper SHORT FLOWERED MONKEYFLOWER
Limited, moist places. May-Jun. Calpine, T21N R14E S19. [*Erythranthe breviflora* (Piper) Nesom]

Mimulus breweri (E. Greene) Cov. BREWER'S MONKEYFLOWER
Damp sandy places and seepage areas. Jun-Sep. Calpine, T21N R14E S19. [*Erythranthe breweri* (Greene) Nesom & Fraga]

Mimulus floribundus Lindl. MANY FLOWERED MONKEYFLOWER
Moist meadows and seep areas. Apr-Aug. To be looked for. Found less than 1 mi from project area (McNair Meadows, T21N R14E S14). [*Erythranthe floribunda* (Douglas ex Lindl.) Nesom]

Mimulus guttatus DC. COMMON MONKEYFLOWER
Common, open meadows, stream banks. Apr-Oct. Sattley, T20N R14E S10; Yuba Pass, T20N R13E S11; Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S26; Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S17. [*Erythranthe guttata* (Fisch. ex DC.) Nesom]

Mimulus leptaleus A. Gray LEAST FLOWERED MONKEYFLOWER
Uncommon, normally above 6800', open gravelly or sandy places. Jun-Aug. To be looked for in the Yuba Pass area as this taxon has been found at Haskell Peak. [*Diplacus leptaleus* (A. Gray) Nesom]

Mimulus lewisii Pursh LEWIS'S MONKEYFLOWER
Local, usually above 5000', stream sides, seeps and springs. Jul-Sep. Calpine, T21N R14E S18. [*Erythranthe lewisii* (Pursh.) Nesom & Fraga]

Mimulus moschatus Lindl. MUSK MONKEYFLOWER
Common, seeps and springs. Jun-Oct. Sattley, T21N R14E S4; Yuba Pass, T20N R13E S11; Sugarloaf, T23N R15E S17. [*Erythranthe moschata* (Lindl.) Nesom]

Mimulus nanus Hook. & Arn. var. ***mephiticus*** (Greene) D.M. Thompson SKUNKY MONKEYFLOWER
Common, open areas of sagebrush, sandy and rocky areas. Jun-Aug. Sattley, T20N R14E S9; Beckwourth Sattley Road (N of Sattley), T21N R14E S28; Frenchman Lake Road, T23N R16E S25; Sugarloaf, T23N R15E S17. [*Diplacus mephiticus* (Greene) Nesom

Mimulus pilosus (Benth.) S. Wats. DOWNY MONKEYFLOWER
Drying creek beds. May-Oct. To be looked for as this taxon has been collected at Webber Lake (UC335557, from Lemmon Herbarium). [*Mimetanthe pilosa* (Benth.) Greene]

Mimulus primuloides Benth. var. ***primuloides*** PRIMROSE MONKEYFLOWER
Common, meadows, springs and seeps. Jun-Aug. Sattley T20N R14E S10; Yuba Pass, T20N R13E S11. [*Erythranthe primuloides* (Benth.) Nesom & Fraga]

Mimulus pulsiferae A. Gray CANDELABRUM MONKEYFLOWER
Moist places along streams. May-Jun. Calpine, T21N R14E S19; Ramelli Ranch, T23N R14E S27. [*Erythranthe pulsiferae* (A. Gray) Nesom]

Mimulus pygmaeus A.L. Grant PIGMY MONKEYFLOWER
Rare, vernally moist gravelly flats and swales. CRPR 4. May-Jun. One record for Sierra Valley (Clifton, #42734); Hwy 49 (S of Vinton), T22N R16E S9. [*Diplacus pygmaeus* (A.L. Grant) Nesom]

Mimulus suksdorfii A.Gray SUKSDORF'S MONKEYFLOWER
Fairly common, moist sandy slopes. May-Aug. Hwy 70 (The Buttes), T23N R15E S35; Beckwourth Pass, T22N R17E S6. [*Erythranthe suksdorfii* (A.Gray) Fraga]

Mimulus tilingii Regel LARGE MOUNTAIN MONKEYFLOWER
Mountain streams and seeps. Jul-Sep. To be looked for in the higher elevations. [*Erythranthe tilingii* (Regel) Nesom]

PLANTAGINACEAE Plantain Family

CALLITRICHE

Callitriche fassettii Schotsman FASSETT'S WATER-STARWORT
Uncommon, submerged in streams and ponds. Apr-Jul. To be looked for as this taxon has been collected just to the northwest of the Sierra Valley region.

Callitriche hetrophylla Pursh var. ***bolanderi*** (Hegelm.) Fassett VARIABLE-LEAF WATER-STARWORT
Common, quite water and ponds. May-Aug. Marble Lane, T22N R15E S18.

Callitriche palustris L. VERNAL WATER-STARWORT
Fairly common, shallow water or on mud. May-Aug. Sattley, T21N R14E S33; Sugarloaf, T23N R15E S17.

COLLINSIA Blue-Eyed Mary

Collinsia parviflora Lindl. SMALL FLOWERED BLUE-EYED MARY
Common, moist slopes and flats. Apr-Jul. Calpine, T21N R14E S16; Sierraville, T20N R14E S24; Antelope Valley, T21N R15E S28; Hwy 70 (The Buttes), T23N R15E S18; Sugarloaf, T23N R15E S17.

Collinsia torreyi A. Gray var. ***torreyi*** TORREY'S BLUE EYED MARY
Fairly common. Moist slopes and flats. May-Aug. Yuba Pass, T20N R13E S11.

GRATIOLA Hedge Hyssop

Gratiola ebracteata DC. BRACTLESS HEDGE HYSSOP
Fairly common, vernal areas and ditches. May-Sep. Marble Lane, T22N R15E S18.

Gratiola neglecta Torr. COMMON HEDGE HYSSOP
Wet or muddy areas and vernal ponds. Jun-Sep. Calpine, T21N R14E S16.

HIPPURIS

Hippuris vulgaris L. MARES-TAIL
Common, sluggish water of marshlands. Jul-Sep. Marble Lane, T22N R14E S13.

LINARIA Toadflax

Linaria dalmatica (L.) Mill subsp. *dalmatica* DALMATIAN TOADFLAX
Invasive weed, roadsides and fields. Jun-Aug. Loyalton, T21N R15E S13.

Linaria vulgaris Hill BUTTER & EGGS
Invasive weed, roadsides. Jun-Jul. Newman Point, T21N R14E S25; Calpine, T21N R14E S20.

PENSTEMON Beardtongue

Penstemon anguineus Eastw. SISKIYOU PENSTEMON
Open conifer forest. Jun-Aug. One record for Sierra Valley (CHSC107490, D. Isle, J. Harvey, #1932, Jun 20, 1998). Newman Point, T21N R14E S25.

Penstemon azureus Benth. var. ***azureus*** AZURE PENSTEMON
Moist open forest. May-Aug. To be looked for in the Yuba Pass and Coburn Lake areas.

Penstemon deustus Lindl. var. ***deustus*** HOT ROCK PENSTEMON
Common, open rocky slopes. May-Jul. Sierraville, T20 R15E S19.

Penstemon deustus Lindl. var. ***pedicellatus*** M.E. Jones NARROW LEAVED HOT ROCK PENSTEMON
Open rocky slopes. May-Jul. Sierraville, T20N R15E S30; Antelope Valley, T21N R15E S27.

Penstemon deustus Lindl. var. ***suffrutescens*** L.F. Hend. WOODY HOT ROCK PENSTEMON
Frequent, open rocky areas. May-Jul. Mapes Canyon T23N R14E S11; Sierraville, T20N R14E S24; Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S17.

Penstemon gracilentus A. Gray SLENDER PENSTEMON
Common, open slopes and flats. Jun-Oct. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S4.

Penstemon hetrodoxus A. Gray SIERRA PENSTEMON
Uncommon, above 7000', meadows and rocky slopes. Jul-Aug. Yuba Pass, T20N R13E S11.

Penstemon laetus A. Gray GAY PENSTEMON
Conifer forests. May-Jul. One collection for the Sierra Valley region (CAS1076201, R.C. Wenk, #396, Oct. 8, 2005). Yuba Pass, T20N R13E S11.

Penstemon newberryi A. Gray var. ***newberryi*** MOUNTAIN PRIDE
Common, cliffs and rocky slopes. Apr-Sep. Sattley, T20N R14E S4.

Penstemon procerus Graham var. ***formosus*** (A. Nels.) Cronq. SMALL FLOWERED PENSTEMON
Limited. Rocky slopes. Jul-Aug. To be looked for as this taxon is found just to the N of the Sierra Valley region at Dixie Peak (T24N R15E S15).

Penstemon rydbergii A. Nels. var. ***oreocharis*** (Greene) N.H. Holmgren MEADOW PENSTEMON
Common, wet to dry meadows. May-Aug. Calpine, T21N R14E S16; Sierraville, T20N R14E S10; Dyson Lane (S of Hwy 70), T22N R15E S6.

Penstemon speciosus Lindl. SHOWY PENSTEMON
Common, dry slopes and sandy flats. May-Jul. Calpine, T21N R14E S17; Antelope Valley, T21N R15E S28; Beckwourth, T23N R14E S14; Sugarloaf, T23N R15E S17.

PLANTAGO Plantain

Plantago lanceolata L. ENGLISH PLANTAIN
Common, disturbed areas and roadsides. Apr-Aug. Calpine, T21N R14E S16; Sierraville, T20N R14E S14; Sugarloaf, T23N R15E S17.

Plantago major L. COMMON PLANTAIN
Common, waste places. May-Sep. Ramelli Ranch, T23N R14E S27.

VERONICA Speedwell, Brooklime

Veronica americana Benth. AMERICAN BROOKLIME
Fairly common, streams and ponds. Apr-Aug. Knuthson Meadows, T21N R14E S5; Antelope Valley, T21N R15E S21; Mapes canyon, T23N R14E S11; Sugarloaf, T23N R15E S17.

Veronica anagallis-aquatica L. GREATER WATER SPEEDWELL
In ponds and along rivers. Introduced from Europe. May-Nov. Sierraville, T20 R14E S24.

Veronica peregrina L. subsp. ***xalapensis*** (Kunth) Pennell PURSLANE SPEEDWELL
Fairly common. Lake margins and vernally moist areas. Apr-Aug. Marble Lane, T22N R15E S18; Antelope Valley, T21N R15E S21 & S28; Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

Veronica scutellata L. MARSH SPEEDWELL
Fairly frequent, boggy meadows and slow moving water. May-Aug. Ramelli Ranch, T23N R14E S27.

Veronica serpyllifolia L. subsp. ***humifusa*** (Dicks.) Syme THYME LEAVED SPEEDWELL
Common, moist areas and stream beds. May-Jul. Loyalton, T21N R16E S30; Sattley, T20N R14E S9.

POLEMONIACEAE Phlox Family

ALICIELLIA

Aliciella leptomeria (A. Gray) J.M. Porter SAND ALICIELLA
Uncommon, small sand dunes. Apr-Jun. Frenchman Lake Road, T23N R16E S25 [= *Gilia l.*].

ALLOPHYLLUM

Allophyllum divaricatum (Nutt.) A.D. Grant & V.E.Grant PINK ALLOPHYLLUM
Scattered, open sites and burns. May-Jul. One record for Sierra Valley (POM181568, J.G. Lemmon, s.n., Jul 1883).

Allophyllum gilioides (Benth.) A.D. Grant & V.E. Grant subsp. ***gilioides*** DENSE FALSE GILIA
Open sagebrush slopes. Jun-Aug. Calpine, T21N R14E S17; Sierraville, T20N R15E S16.

Allophyllum gilioides (Benth.) A.D. Grant & V.E. Grant subsp. ***violaceum*** (A. Heller) A.G. Day VIOLET-FLOWERED ALLOPHYLLUM
Scattered, open sandy and gravelly places. May-Jun. Calpine, T21N R14E S27; Marble Lane, T22N R14E S13; Antelope Valley, T21N R15E S28.

Allophyllum integrifolium (Brand) A.D. Grand & V.E. Grant WHITE ALLOPHYLLUM
Open moist rocky areas. Jun-Aug. To be looked for as this taxon has been collected just to the W of Yuba Pass.

COLLOMIA

Collomia grandiflora Lindl. LARGE-FLOWERED COLLOMIA
Common, dry open areas. Apr-Jul. Calpine, R21N R14E S16; Beckwourth Sattley Road (S of Beckwourth), T22N R14E S2; Sugarloaf, T23N R15E S17.

Collomia linearis Nutt. NARROW-LEAVED COLLOMIA
Common, dry open areas. May-Aug. Beckwourth Sattley Road, T22N R14E S11; Sierraville, T20N R14E S13; Sugarloaf, T23N R15E S17.

Collomia tinctoria Kellogg STAINING COLLOMIA
Open places and disturbed areas. Jun-Aug. Ramelli Ranch, T23N R14E S27.

ERIASTRUM

Eriastrum signatum D. Gowen WELL MARKED ERIASTRUM
Sandy soils and sagebrush scrub. May-Aug. Newman Point, T21N R14E S25; Vinton, T23N R16E S35.

Eriastrum sparsiflorum (Eastw.) H. Mason FEW-FLOWERED ERIASTRUM
Scattered, dry rocky or sandy slopes. CRPR 4. Jun-Jul. Antelope Valley, T21N R15E S27; Hwy 49, T22N R16E S8; Newman Point, T21N R14E S25; Beckwourth, T23N R14E S26; Vinton, T23N R16E S35; Beckwourth Pass, T22N R17E S6; Sugarloaf, T23N R15E S17.

Eriastrum wilcoxii (A. Nels.) H. Mason WILCOX'S ERIASTRUM
Uncommon, dry sandy slopes and flats. Jun-Jul. Trosi Canyon, T23N R16E S18.

GILIA

Gilia brecciarum M.E. Jones subsp. ***brecciarum*** LEAFY GILIA
Common, sandy areas in sagebrush. May-Jun. Vinton, T22N R16E S34; Ramelli Ranch, T23N R14E S27; Beckwourth Pass, T22N R17E S6; Loyalton, T21N R16E S15.

Gilia inconspicua (Sm.) Sweet SHY GILIA
Occasional, dry sandy flats. May-Jun. Ramelli Ranch, T23N R14E S27; Frenchman Lake Road, T23N R16E S25; Beckwourth Pass, T22N R17E S6.

Gilia modocensis Eastw. MODOC GILIA
Occasional, open rocky areas. May-Jun. Beckwourth Pass, T22N R17E S6; Vinton, T23N R16E S34.

Gilia sinuata Benth. SINUATE GILIA
Fairly common, open sandy areas. Apr-Jun. Frenchman Lake Road, T23N R17E S19.

IPOMOPSIS

Ipomopsis aggregata (Pursh) V.E. Grant SCARLET GILIA
Locally frequent, open sandy and rocky slopes. Jun-Sep. Ramelli Ranch, T23N R14E S27; Sierraville, T20N R14E S13; Sugarloaf, T23N R15E S16.

Ipomopsis congesta (Hook.) V.E. Grant subsp. ***montana*** (A. Nels. & P.B. Kenn.) V.E. Grant BALL HEADED GILIA
Uncommon. Dry rocky ridges and slopes. Jun-Aug. Lincoln Ridge, T20N R13E S23.

LEPTOSIPHON

Leptosiphon ciliatus (Benth.) Jeps. WISKER BRUSH
Common, dry flats and slopes. Apr-Jul. Calpine, T21N R14E S16; Mapes Canyon, T23N R14E S11; Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11; Sugarloaf, T23N R15E S17 [= *Linanthus c.*].

Leptosiphon harknessii (Curran) J.M. Porter & L.A. Johnson HARKNESS' FLAXFLOWER
Uncommon. Open gravelly flats. Jun-Aug. Calpine, T21N R14E S20 [= *Linanthus h.*].

LINANTHUS

Linanthus pungens (Torr.) J.M. Porter & L.A. Johnson GRANITE PRICKLY PHLOX
Common, sandy flats, rocky slopes and ridges. May-Aug. Antelope Valley, T21N R15E S16; Ramelli Ranch, T23N R14E S27; Lincoln Ridge, T20N R13E S23 [= *Leptodactylon p.*].

MICROSTERIS

Microsteris gracilis (Hook.) Greene SLENDER PHLOX
Common, drying vernal areas and open grassy areas. Mar-Aug. Beckwourth Sattley Road, T21N R14E S3; Sattley, T21N R14E S33; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

NAVARRETIA

Navarretia breweri (A. Gray) Greene BREWER'S NAVARRETIA
Fairly common, vernally moist slopes. May-Aug. Newman Point, T21N R14E S25; Antelope Valley, T21N R15E S28.

Navarretia capillaris (Kellogg) Kuntze MINIATURE GILIA
Common, sandy flats and slopes. Jun-Aug. Calpine, T21N R14E S16.

Navarretia divaricata (A. Gray) Greene subsp. ***divaricata*** MOUNTAIN NAVARRETIA
Moist slopes and flats. Jun-Aug. Sattley, T21N R14E S30.

Navarretia divaricata (A. Gray) Greene subsp. ***vividior*** (Jeps. & V.L. Bailey) H. Mason DIVARICATE NAVARRETIA
Clay or volcanic soils. May-Aug. One record possibly from the Sierra Valley region (UC335366, Unknown, 1873; from the Lemmon Herbarium).

Navarretia intertexta (Benth.) Hook. NEEDLE-LEAVED NAVARRETIA
Common. Vernal pools, flats and stream beds. Jun-Aug. Beckwourth Sattley Road (N of Sattley), T21N R14E S22 [= *Navarretia intertexta* subsp. *intertexta*].

Navarretia leptalea (A. Gray) L.A. Johnson subsp. ***leptalea*** BRIDGES' NAVARRETIA
Uncommon. Sagebrush flats. Jun-Aug. Beckwourth Sattley Road (N of Sattley), T21N R14E S21; Beckwourth; T23N R14E S26 [= *Gilia l.* subsp. *l.*].

Navarretia leucocephala Benth. subsp. ***minima*** (Nutt.) A.G. Day LEAST NAVARRETIA
Locally frequent, vernal flats. Jun-Aug. Calpine, T21N R14E S16; Dyson Lane, T22N R16E S18; Knuthson Meadows, T21N R14E S5; Sugarloaf, T23N R15E S17.

Navarretia mitacarpa Greene PASO ROBLES NAVARRETIA
Open grassy areas. May-Jul. One record listed for Plumas County (POM181565, J. G. Lemmon, s.n., Plumas, Sierra Nevada; Northern Sierra Nevada region, Sierra Valley) [= *N. jaredii*]. This taxa way out of range and was probably collected in the Santa Barbara area.

Navarretia propinqua Suksd. GREAT BASIN NAVARRETIA
Common, vernally moist sites and drying stream beds. Jun-Oct. Calpine, T21N R14E S29; Marble Lane, T22N R14E S13 [= *Navarretia intertexta* subsp. *propinqua*].

PHLOX

Phlox austromontana Coville MOUNTAIN PHLOX
Uncommon, dry rocky slopes. May-Jun. Sugarloaf, T23N R15E S17.

Phlox diffusa Benth. SPREADING PHLOX
Frequent, dry flats and slopes. Apr-Sep. Hwy 49 (Correco Canyon), T22N R16E S27; Frenchman Lake Road, T23N R16E S25; Sierraville, T20 R15E S19.

Phlox hoodii Richardson subsp. ***canescens*** (Torr. & A. Gray) Wherry CANESCENT PHLOX
Uncommon, openings in sagebrush. May-Jul. Beckwourth Sattley Road, T22N R14E S11; Newman Point, T21N R14E S25.

Phlox speciosa Pursh SHOWY PHLOX
Fairly frequent, sandy or rocky slopes. Apr-Jul. Ramelli Ranch, T23N R14E S27; Beckwourth Peak (E of), T22N R14E S10.

Phlox stansburyi (Torr.) A. Heller STANSBURY'S PHLOX
Common, dry flats or slopes, often in sagebrush. May-Jul. Loyalton, T21N R16E S8; Beckwourth Pass, T22N R17E S6.

POLEMONIUM

Polemonium californicum Eastw. LOW POLEMONIUM
Moist shaded areas above 6000 ft. Jun-Aug. Yuba Pass, T20N R13E S11.

Polemonium micranthum Benth. SMALL-FLOWERED POLEMONELLA
Common, dry openings in sagebrush. Apr-May. Loyalton, T21N R15E S12; Ramelli Ranch, T23N R14E S27; Newman Point, T21N R14E S25.

Polemonium occidentale Greene WESTERN POLEMONIUM
Infrequent, wet meadows and streams. Jun-Aug. Sattley, T20N R14E S9 & S10 [= *Polemonium occidentale* subsp. *occidentale*].

POLYGONACEAE Buckwheat Family

ACONOGONON

Aconogonon phytolaccifolium (Small) Rydb. ALPINE KNOTWEED
Fairly common above 5000 ft., moist rocky areas. Jun-Sep. Sattley, T20N R14E S9 [= *Polygonum p.*].

BISTORTA

Bistorta bistortoides (Pursh) Small BISTORT
Common, open wet meadows. May-Jul. Sattley, T20N R14E S9 [= *Polygonum b.*].

CHORIZANTHE Spineflower

Chorizanthe watsonii Torr. & A. Gray WATSON'S SPINE-FLOWER
Limited, dry sandy or gravelly slopes. Apr-May. Beckwourth Pass, T22N R17E S7.

ERIOGONUM Buckwheat

Eriogonum baileyi S. Wats. var. ***baileyi*** BAILEY'S WILD BUCKWHEAT
Dry sandy slopes and flats. Jun-Jul. Hwy 49 (S of Vinton), T22N R16E S4; Sugarloaf, T23N R15E S17.

Eriogonum baileyi S. Wats. var. ***praebens*** (Gand.) Reveal BAILEY'S HAIRY WILD BUCKWHEAT
Dry sandy slopes and flats. CRPR 4. Jun-Jul. Hwy 49 (S of Vinton), T22N R16E S17; Frenchman Lake Road, T23N R16E S25; Vinton, T23N R16E S34.

Eriogonum caespitosum Nutt. MATTED WILD BUCKWHEAT
To be looked for especially in dry rocky areas. Apr-Jul. This taxon has been collected at both Webber Peak and Dog Valley in Sierra County and to the northwest of Portola, Plumas County.

Eriogonum douglasii Benth. var. ***meridionale*** Reveal DOUGLAS'S WILD BUCKWHEAT
Volcanic scalds and rocky flats. May-Jul. Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Beckwourth Sattley Road (N of Sattley), T21N R14E S22; Newman Point, T21N R14E S25.

Eriogonum elatum Benth. var. ***elatum*** TALL WILD BUCKWHEAT
Frequent, dry rocky slopes. Jun-Sep. Ramelli Ranch, T23N R14E S27; Beckwourth Pass, T22N R17E S6.

Eriogonum elatum Benth. var. ***villosum*** Jeps. TALL HAIRY WILD BUCKWHEAT
Locally common, dry rocky slopes and flats. Jun-Oct. Frenchman Lake Road, T23N R16E S3; Calpine, T21N R14E S20; Snow Lake (N of Chilcoot), T23N R17E S7.

Eriogonum gracile Benth. var. ***gracile*** SLENDER WOOLLY WILD BUCKWHEAT
Dry sandy to gravelly slopes and flats. Jun-Sep. Hwy 49 (S of Vinton), T22N R16E S4 [Glenn Clifton, Plumas County and Plumas National Forest Flora, 1999 draft & 2005 draft].

Eriogonum lobbii Torr. & A. Gray LOBB'S WILD BUCKWHEAT
Dry rocky slopes and open ridges. May-Jul. To be looked for, found just to the N of the Sierra Valley region.

Eriogonum luteolum Greene var. ***pedunculatum*** (S. Stokes) Reveal GOLDEN CARPET WILD BUCKWHEAT
Two historical records for the Loyalton area (CAS131670, Alice Eastwood, 7794, Jun 29, 1915 & CAS131717, Alice Eastwood 7870, Jun 29, 1918).

Eriogonum marifolium Torr. & A. Gray var. ***marifolium*** MARUM-LEAF WILD BUCKWHEAT
Sandy and rocky soils. Jun-Aug. One historical record for Sierra Valley (CAS131196, Anna Head, s.n., Jun 21, 1921, Campbells Hot Springs, Feather River region). Sierraville, T20N R15E S19

Eriogonum microthecum Nutt. var. ***ambiguum*** (M.E. Jones) Reveal YELLOW-FLOWERED GREAT BASIN WILD BUCKWHEAT
Uncommon, rocky sagebrush slopes. Jul-Sep. Sugarloaf, T23N R15E S17.

Eriogonum microthecum Nutt. var. ***laxiflorum*** Hook. LAX-FLOWERED GREAT BASIN WILD BUCKWHEAT
Rocky slopes. Jul-Sep. To be looked for on the E side of Sierra Valley.

Eriogonum nudum Benth. var. ***deductum*** (Greene) Jeps. FEW-FLOWERED NAKED WILD BUCKWHEAT
Common, dry sandy to rocky slopes. Jun-Sep. Mapes Canyon, T23N R14E S11.

Eriogonum nudum Benth. var. ***nudum*** NAKED WILD BUCKWHEAT
Common, dry sandy to rocky slopes. Jun-Sep. Calpine, T21N R14E S17.

Eriogonum nudum Benth. var. ***oblongifolium*** S. Wats. HAIRY-STEMMED NAKED WILD BUCKWHEAT
Dry flats and slopes. Jun-Oct. Coburn Lake, T20N R14E S20 (RENO7987, W & N Harnach, #932, was annotated to *E. n.* var. *nanafolium* by J.L. Reveal).

Eriogonum nudum Benth. var. ***pubiflorum*** Benth. HAIRY-FLOWERED NAKED WILD BUCKWHEAT
Dry rocky slopes and flats. Jun-Sep. Frenchman Lake Road, T23N R16E S10.

Eriogonum ovalifolium Nutt. var. ***purpureum*** (Nutt.) Durand PURPLISH-FLOWERED OVAL-LEAVED BUCKWHEAT
Dry grassy valley floor. Jun-Sep. Dyson Lane, T22N R15E S6.

Eriogonum spergulinum A. Gray var. ***reddingianum*** (M.E. Jones) J.T. Howell SPURRY WILD BUCKWHEAT
Very common in logged areas or other disturbed areas. Jun-Sep. Sattley, T20N R14E S9.

Eriogonum strictum Benth. var. ***anserinum*** (Greene) S. Stokes YELLOW-FLOWERED STRICT WILD BUCKWHEAT
Fairly common, rocky slopes, flats and ridges, often in the sagebrush. Jul-Sep. Mapes Canyon, T23N R14E S11; Calpine, T21N R14E S16; Newman Point, T21N R14E S25; Antelope Valley, T21N R15E S28.

Eriogonum strictum Benth. var. ***proliferum*** (Torr. & A. Gray) C.L. Hitchc. WIDELY-SPREADING WILD BUCKWHEAT
Infrequent, open rocky ridges and slopes. Jul-Sep. Mapes Canyon, T23N R14E S11; Sierraville, T20N R14E S13.

Eriogonum umbellatum Torr. var. ***modocense*** (Greene) S. Stokes MODOC SULPHUR FLOWER
Uncommon, sagebrush flats. Jun-Sep. Beckwourth Sattley Road, T22N R14E S11 (Clifton #26322) [*E. u.* var. *polyanthum* misappl.].

Eriogonum umbellatum Torr. var. ***nevadense*** Gand. NEVADA SULPHUR-FLOWERED WILD BUCKWHEAT
Dry sandy to dry rocky slopes and flats. Jun-Sep. Antelope Valley, T21N R15E S16; Newman Point, T21N R14E S25; Ramelli Ranch, T23N R14E S27.

Eriogonum umbellatum Torr. var. ***polyanthum*** (Benth.) M.E. Jones MANY-FLOWERED SULPHUR-FLOWERED WILD BUCKWHEAT
Frequent, dry rocky or sandy slopes and flats. Jun-Sep. Beckwourth Sattley Road (S of Beckwourth), T22N R14E S11; Ramelli Ranch, T23N R14E S27.

Eriogonum vimineum Benth. WICKER WILD BUCKWHEAT
Fairly common, sandy flats. May-Oct. Ramelli Ranch, T23N R14E S27; Beckwourth, T23N R14E S26; Hwy 70 (E of The Buttes), T23N R15E S35; Vinton, T23N R16E S28; Co. Road A-24 (N of Loyalton), T22N R15E S25.

PERSICARIA Smartweed

Persicaria amphibia (L.) Gray WATER SMARTWEED
Common, vernal ponds. Jun-Aug. Calpine, T21N R14E S16; Little Last Chance Lake, T22N R15E S9; Hwy 49 (W of Sierraville), T20N R14E S11; Ramelli Ranch, T23N R14E S26.

POLYGONUM Knotweed

Polygonum argyrocoleon Kunze PERSIAN KNOTWEED
Uncommon. Grasslands and saline areas. Jun-Aug. Knuthson Meadows, T21N R14E S5.

Polygonum aviculare L. var. *aviculare* COMMON KNOTWEED
Scattered, disturbed soils. Jun-Sep. Beckwourth Sattley Road (just S of the Sierra-Plumas Co. line), T21N R14E S3.

Polygonum aviculare L. subsp. *depressum* (Meisn.) Arcang. COMMON KNOTWEED
Scattered. Disturbed soils. Jun-Sep. Ramelli Ranch, T23N R24E S27; Beckwourth Sattley Road (S of Beckwourth), T22N R14E S11.

Polygonum douglasii Greene DOUGLAS' KNOTWEED
Sandy soils in sagebrush. Jun-Jul. Ramelli Ranch, T23N R14E S27; Yuba Pass, T20N R13E S11; Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16.

Polygonum majus (Meisn.) Piper SHOWY KNOTWEED
Sandy soils in sagebrush. Jun-Jul. Ramelli Ranch, T23N R14E S27 [= *P. douglasii* subsp. *m.*].

Polygonum parryi Greene PARRY'S KNOTWEED
Vernally moist areas. May-Jul. Calpine, T21N R14E S20; Beckwourth Sattley Road (N of Sattley), T21N R14E S21.

Polygonum polygaloides Meisn. subsp. ***confertiflorum*** (Piper) J.C. Hickman DENSE-FLOWERED KNOTWEED

Vernally moist pools and swales. Jun-Jul. Ramelli Ranch, T23N R14E S27; Heriot Lane, T22N R15E S21; Calpine, T21N R14E S16.

Polygonum polygaloides Meisn. subsp. ***esotericum*** (L.C. Wheeler) J.C. Hickman MODOC COUNTY KNOTWEED
Uncommon, vernally moist areas. CRPR 1B. Jun-Jul. Beckwourth Sattley Road, T22N R14E S11; Marble Lane, T22N R14E S13; Antelope Valley, T21N R15E S28.

Polygonum polygaloides Meisn. subsp. ***kelloggi*** (Greene) J.C. Hickman KELLOGG'S KNOTWEED
Vernal areas and roadside ditches. Jun-Sep. Marble Lane, T22N R15E S18; Calpine, T21N R14E S20.

Polygonum shastense W.H. Brewer SHASTA KNOTWEED
Rocky, gravelly slopes. Jul-Sep. To be looked for as this taxon has been collected just W of Yuba Pass.

Polygonum spergulariiforme Small FALL KNOTWEED, SPURREY KNOTWEED
Dry slopes. Jun-Sep. Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E 20; Sierraville, T20N R15E S20; Newman Point, T21N R14E S25 [= *P. douglasii* subsp. *s.*].

RUMEX Dock

Rumex acetosella L. SHEEP SORREL
Common, disturbed areas. Apr-Aug. Ramelli Ranch, T23N R14E S27; Coburn Lake, T20N R14E S20; Dyson Lane (S of Hwy 70), T23N R15E S31; Sugarloaf, T23N R15E S17.

Rumex californicus Rech. f. CALIFORNIA DOCK
Moist areas. May-Sep. To be looked for in the Yuba Pass areas as this taxon has been collected to the west [= *R. salicifolius* var. *denticulatus*].

Rumex crispus L. CURLEY-LEAVED DOCK
Common, disturbed areas. May-Oct. Marble Lane, T22N R15E S18; Loyalton, T21N R15E S13; Sugarloaf, T23N R15E S17.

Rumex fueginus Phil. GOLDEN DOCK
Uncommon, margins of ponds and slow streams. Jun-Sep. Heriot Lane, T22N R15E S28.

Rumex lacustris Greene WETLAND WILLOW DOCK
Infrequent, vernal ponds, marshes and sometimes alkali sinks. Jul-Sep. Dyson Lane (S of Hwy 70), T22N R15E S17; Heriot Lane, T22N R15E S21.

Rumex paucifolius Nutt. ALPINE SHEEP SORREL
Locally common, drying meadows and sagebrush scrub. May-Sep. Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S16; Dyson Lane (S of Hwy 70), T23N R15E S31.

Rumex transitorius Rech. f. TRANSITORY WILLOW DOCK
Infrequent. May-Sep. To be looked for as this taxon has been collected at Portola [= *Rumex salicifolius* var. *t.*].

Rumex triangulivalvis (Danser) Rech. f. TRIANGULAR FRUITED DOCK
Scattered, moist areas. Jun-Sep. Beckwourth Sattley Road, T21N R14E S9; Calpine, T21N R14E S16 [= *R. salicifolius* var. *t.*].

PRIMULACEAE Primrose Family

PRIMULA Primrose

Primula hendersonii (A. Gray) Mast & Reveal HENDERSON'S SHOOTING STAR
Locally common, shaded meadows. Apr-May. Calpine, T21N R14E S29; Coburn Lake, T20N R14E S29; Sattley, T21N R14E S32 [= *Dodecatheon hendersonii*].

Primula jeffreyi (Van Houtte) Mast & Reveal JEFFERY'S SHOOTING STAR
Locally common, wet meadows and stream margins. Jun-Aug. Yuba Pass, T20N R13E S11 [= *Dodecatheon jeffreyi*].

Primula suffrutescens A. Gray SIERRA PRIMROSE
Rocky slopes and cliffs in areas of late melting snow. Jul-Aug. To be looked for in the Lincoln Ridge and Coburn Lake areas.

Primula tetrandra (Greene) Mast & Reveal ALPINE SHOOTING STAR
Locally frequent, wet meadows. May-Aug. Sattley, T20 R14E S9; Yuba Pass, T20N R13E S11 [= *Dodecatheon alpinum*].

RANUNCULACEAE Buttercup Family

ACONITUM Monkshood

Aconitum columbianum Nutt. subsp. ***columbianum*** COLUMBIA MONKSHOOD
Fairly common in thickets along streams and meadows. Jul-Aug. Sattley, T21N R14E S9.

ACTAEA Baneberry

Actaea rubra (Aiton) Willd. WESTERN BANEBERRY
Moist shaded areas. May-Jun. Sattley, T21N R14E S9.

AQUILEGIA Columbine

Aquilegia formosa DC. RED COLUMBINE
Fairly common in moist areas. Jun-Sep. Sattley, T20N R14E S9; Yuba Pass, T20N R13E S11; Sierraville, T20N R15E S17; Sugarloaf, T23N R15E S17.

CALTHA Marsh Marigold

Caltha leptosepala DC. HOWELL'S MARSH MARIGOLD
Fairly common, wet meadows. May-Jul. Yuba Pass, T20N R13E S11.

DELPHINIUM Larkspur

Delphinium andersonii A. Gray ANDERSON'S LARKSPUR
Common in sagebrush scrub. Apr-Jun. Calpine, T21N R14E S16; Beckwourth Sattley Road, T21N R14E S3; Antelope Valley, T21N R15E S28; Ramelli Ranch, T23N R14E S27; Chilcoot, T23N R16E S26.

Delphinium depauperatum Nutt. DWARF LARKSPUR
Open moist woods. May-Jul. Antelope Valley, T21N R15E S16.

Delphinium glaucum S. Wats. GLAUCOUS LARKSPUR
Willows and wet meadow margins of higher elevations. Jul-Sep. To be looked for in the Yuba Pass area as this taxon has been found just to the west at Haskell Peak.

Delphinium gracilentum Greene FOREST LARKSPUR
Moist, partially shaded slopes. May-Jul. Calpine, T21N R14E S17; Sattley, T20N R14E S4.

Delphinium nudicaule Torr. & A. Gray RED LARKSPUR
Open woods. Mar-Jun. Ramelli Ranch, T23N R14E S27; Knuthson Meadows, T21N R14E S6; Calpine, T21N R14E S17.

Delphinium nuttallianum Pritz. NUTTALL'S LARKSPUR
Fairly common. Open woods and brushy slopes. May-Jul. Coburn Lake, T20N R14E S29; Sattley, T21N R14E S9; Antelope Valley, T21N R15E S28; Beckwourth Sattley Road (NE of Calpine), T21N R14E S9; Ramelli Ranch, T23N R14E S27.

Delphinium polycladon Eastw. HIGH MOUNTAIN LARKSPUR
Stream banks. Jul-Sep. One collection for the Sierra Valley (SJSU15163, N. Hopkins, #1722, 5-26-1993, Dyson lane). NE corner of Sierra Valley.

MYOSURUS Mouse Tail

Myosurus apetalus Gay MOUSE TAIL
Fairly common, vernal areas and ditches. Apr-Jul. Marble Lane, T22N R15E S18; Dyson Lane, T22N R15E S29.

Myosurus minimus L. COMMON MOUSE TAIL
Fairly common, roadside ditches and vernal areas. Apr-Jul. Hwy 49 (W of Loyalton), T21N R15E S10; Calpine, T21N R14E S16.

RANUNCULUS Buttercup

Ranunculus alismifolius Benth. var. ***alismifolius*** WATER PLANTAIN BUTTERCUP
Common, wet meadows and bogs. Mar-Jun. Calpine, T21N R14E S16; Knutson Meadows, T21N R14E S5.

Ranunculus alismifolius Benth. var. ***lemmonii*** (A. Gray) L.D. Benson SMALL WATER PLANTAIN BUTTERCUP
Damp meadows. May-Aug. One record for the Sierra Valley region (RENO15352, Mrs. C. G. Gulling, #1202, no date, Sierra Valley).

Ranunculus andersonii A. Gray ANDERSON'S BUTTERCUP
Uncommon, rocky volcanic areas. Mar-May. Beckwourth Sattley Road, T22N R14E S23; Sugarloaf, T23N R15E S17.

Ranunculus aquatilis L. var. ***diffusus*** With. WATER BUTTERCUP
Locally common. Apr-Jul. Marble Lane, T22N R14E S13 and T22N R15E S18.

Ranunculus aquatilis L. var. ***hispidulus*** Drew WATER BUTTERCUP
Common, roadside ditches. Apr-Jul. Marble Lane, T22N R14E S13; Beckwourth Sattley Road, T22N R14E S26.

Ranunculus cymbalaria Pursh DESERT BUTTERCUP
Fairly common, generally wet areas. May-Aug. Sattley, T21N R14E S33; Sierraville, T20N R15E S19 & 20; Sugarloaf, T23N R15E S20 & S17 [= *R. c.* var. *saximontanus*].

Ranunculus flammula L. var. ***ovalis*** (Bigelow) L.D. Benson CROWFOOT, CREEPING BUTTERCUP
Fairly common, wet areas and mud flats. Jun-Aug. Marble Lane, T22N R15E S18.

Ranunculus glaberrimus Hook. var. ***ellipticus*** (Greene) Greene ELLIPTIC LEAVED SAGEBRUSH BUTTERCUP
Common in sagebrush. Mar-May. Calpine, T21N R14E S16 & S20.

Ranunculus glaberrimus Hook. var. ***glaberrimus*** SAGEBRUSH BUTTERCUP
Common in sagebrush. Mar-May. Beckwourth Sattley Road, T22N R14E S34; Calpine, T21N R14E S16.

Ranunculus macounii Britton MACOUN'S BUTTERCUP
One record for Sierra Valley (CAS905447, Greg Sommers, 184, 1-Jul-1976, Sierra Valley Marsh). Marble Lane, T22N R15E S18. Considering the number of confirmed collections and range in the state, this is probably a misidentification and most likely *R. occidentalis* var. *o.*

Ranunculus occidentalis Nutt. var. ***occidentalis*** WESTERN BUTTERCUP
Fairly common in vernally moist areas. Apr-Jun. Calpine, T21N R14E S16; Sierraville, T20N R15E S17; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Ranunculus sceleratus L. var. ***multifidus*** Nutt. CURSED BUTTERCUP or CROWFOOT
Wet areas along streams and pool margins. Jun-Aug. Ramelli Ranch, T23N R14E S27.

Ranunculus testiculatus Crantz. TUBERCLED BUTTERCUP
Locally common, roadsides and waste places. Mar-May. Hwy 49 at Dyson Lane, T22N R16E S17.

THALICTRUM Meadow Rue

Thalictrum fendleri A. Gray var. ***fendleri*** FENDLER'S MEADOW RUE
Common on meadow edges and along streams. May-Aug. Sattley, T21N R14E S9; Coburn Lake, T20N R13E S36.

Thalictrum fendleri A. Gray var. ***polycarpum*** Torr. MEADOW RUE
Open to shaded conifer forest. Mar-Jun. One historical record for Sierra Valley (UCSC289, "unknown; Jun 8 1889, Sierra, Sierra Valley").

Thalictrum sparsiflorum Fisch. & C.A. Mey. FEW FLOWERED MEADOW RUE
Moist places among willows. Jul-Sep. To be looked for in the Yuba Pass area as this taxon has been reported just to the west.

RHAMNACEAE Buckthorn Family

CEANOTHUS Wild Lilac

Ceanothus cordulatus Kellogg MOUNTAIN WHITETHORN
Common, open flats, slopes and logged areas. May-Jul. Ramelli Ranch, T23N R14E S27; Yuba Pass, T20N R13E S11; Calpine, T21N R14E S19.

Ceanothus prostratus Benth. MAHALA MATS
Common, especially in burn areas. Apr-Jun. Sattley, T20N R14E S4; Newman Point, T21N R14E S25; Calpine, T21N R14E S17.

Ceanothus velutinus Douglas var. ***velutinus*** TOBACCO BUSH
Very common in logged and burn areas. May-Jul. Sattley, T20N R14E S4.

FRANGULA Coffee Berry

Frangula purshiana (DC.) J.G. Cooper CASCARA SAGRADA
Forest edges and stream sides. May-Jul. Beckwourth Peak, T22N R14E S9 [= *Rhamnus p.*].

Frangula rubra (Greene) Grubov SIERRA COFFEEBERRY
Open brushy slopes. Apr-Jun. Sugarloaf, T23N R15E S17.

ROSACEAE Rose Family

AMELANCHIER Service-Berry

Amelanchier alnifolia (Nutt.) M. Roem. SERVICE-BERRY
Fairly frequent in moist scrubland and open forest. May-Jun. Beckwourth Sattley Road, T22N R14E S10 & S23; Sattley, T20N R14E S4.

Amelanchier utahensis Koehne UTAH SERVICE-BERRY
Common, open slopes and flats. Apr-Jun. Calpine, T21N R14E S16; Newman Point, T21N R14E S25; Mapes Canyon, T23N R14E S11.

CERCOCARPUS Mtn. Mahogany

Cercocarpus ledifolius Nutt. var. ***intermontanus*** N.H. Holmgren CURL-LEAVED MOUNTAIN MAHOGANY
Scattered, open rocky slopes. Apr-Aug. Mapes Canyon, T23N R14E S11.

Cercocarpus ledifolius Nutt. var. ***ledifolius*** CURL-LEAVED MOUNTAIN MAHOGANY
Common, open rocky slopes. Apr-May. Harding Point, T21N R15E S31; Beckwourth Peak, T22N R14E S8; Beckwourth Pass, T23N R17E S31.

COMARUM

Comarum palustre L. MARSH CINQUEFOIL
Uncommon, floating fens. May-Aug. Sattley, T21N R14E S9; Coburn Lake, T20N R14E S29 [= *Potentilla p.*].

DRYMOCALLIS

Drymocallis glandulosa (Lindl) Rydb. var. ***reflexa*** (Greene) Ertter STICKY CINQUEFOIL
Fairly common, dry slopes and open forest. May-Jul. Mapes Canyon, T23N R14E S11; Calpine, T21N R14E S19; Sierraville, T20N R15E S17; Antelope Valley, T21N R15E S28 [= *Potentilla g.* subsp. *r.*].

Drymocallis lactea (Greene) Rydb. var. ***austiniae*** (Jeps.) Ertter AUSTIN'S WOODBEAUTY
Moist areas on rocky slopes and in forest openings. Jun-Jul. Calpine, T21N R14E S29 [= *Potentilla glandulosa* subsp. *ashlandica*].

Drymocallis lactea (Greene) Rydb. var. ***lactea*** SIERRAN WOODBEAUTY
Uncommon, edges of meadows and rocky slopes. Jun-Aug. Coburn Lake, T20N R14E S29 [= *Potentilla glandulosa* subsp. *nevadensis*].

FRAGARIA Strawberry

Fragaria virginiana Mill. MOUNTAIN STRAWBERRY
Lodgepole pine forest floors and moist shaded areas. May-Jul. Sattley, T20N R14E S9.

GEUM Avens

Geum macrophyllum Willd. var. ***perincisum*** (Rydb.) Raup LARGE LEAVED AVENS
Uncommon, wet roadside ditches, streams and meadows. May-Aug. Sattley, T20N R14E S10.

Geum triflorum Pursh OLD MANS WHISKERS, PURPLE AVENS
Dry meadow edges, sagebrush scrub. May-Jul. To be looked as this taxon is found just N of the project area.

HOLODISCUS

Holodiscus discolor (Pursh) Maxim. CREAM BUSH
Moist woodland edges, meadow edges. May-Aug. Sugarloaf, T23N R15E S17.

HORKELIA

Horkelia fusca Lindl. var. ***brownii*** (Rydb.) Ertter & Reveal TAWNY HORKELIA
Open forests and volcanic ground. Jul-Aug. Sierraville, T20N R15E S8; Calpine, T21N R14E S16 [= *Horkelia fusca* subsp. *pseudocapitata*].

Horkelia fusca Lindl. subsp. ***parviflora*** (Hook. & Arn.) Wawra DUSKY HORKELIA
Common, sagebrush scrub. May-Jun. Calpine, T21N R14E S16; Harding Point (N of Sierraville on Hwy 49), T21N R14E S20; Dyson Lane, T22N R15E S5.

IVESIA Mousetail

Ivesia aperta (J.T. Howell) Munz var. ***aperta*** SIERRA VALLEY IVESIA
Fairly common in scattered localities. Sagebrush and sandy areas. Predominately on the northern and eastern sides of the valley. CRPR 1B. Jun-Jul. Ramelli Ranch, T23N R14E S27; Antelope Valley, T21N R15E 17; Loyalton, T21N R16E S16.

Ivesia baileyi S. Wats. var. ***baileyi*** BAILEY'S IVESIA
Rare, volcanic cliffs. CRPR 2B. Jun-Aug. Little Last Chance Creek, T23N R16E S4 (just beyond the project boundary); Sugarloaf, T23N R15E S20.

Ivesia sericoleuca (Rydb.) Rydb. PLUMAS IVESIA
Fairly common in scattered localities. Seasonally wet clay soils. Primarily on the W side of the valley. CRPR 1B. Jun-Aug. Calpine, T21N R14E S16; and many locations along the Beckwourth Sattley Road.

Ivesia webberi A. Gray WEBBER'S IVESIA
Rare, volcanic scalds and cobbley areas. CRPR 1B. May-Jul. Hwy 49, T22N R16E S16.

MALUS Apple

Malus pumila Mill. DOMESTIC APPLE
Apple trees have apparently started from seed in several locations, notably Marble Lane and Hwy 49 W of Sattley. There are also many remnant orchards throughout the valley.

POTENTILLA Cinquefoil

Potentilla anserina L. subsp. ***anserina*** SILVER WEED
Infrequent, moist ± alkaline sites. May-Oct. Beckwourth, T23N R14E S27; Sugarloaf, T23N R15E S17.

Potentilla biennis Greene BIENNIAL CINQUEFOIL
Uncommon, moist sandy areas. May-Aug. Marble Lane, T22N R14E S13.

Potentilla gracilis Hook. var. ***elemeri*** (Rydb.) Jeps. ELEMER'S CINQUEFOIL
Drying meadows. Jun-Aug. Beckwourth, T23N R14E S26.

Potentilla gracilis Hook. var. ***fastigiata*** (Nutt.) S. Wats. SLENDER CINQUEFOIL
Fairly common, dry meadows and open forest. May-Sep. Sierraville, T20N R14E S11.

Potentilla gracilis Hook. var. ***flabelliformis*** (Lehm.) Torr. & A. Gray FAN LEAVED CINQUEFOIL
Drier parts of meadows. Jun-Aug. Ramelli Ranch, T23N R14E S27.

Potentilla millefolia Rydb. MANY LEAVED CINQUEFOIL
Common, wet meadows. May-Sep. Calpine, T21N R14E S16; Sattley, T21N R14E S33; Knuthson Meadows, T21N R14E S5.

Potentilla rivalis Nutt. BROOK CINQUEFOIL
Infrequent, roadside ditches. May-Oct. Marble Lane, T22N R15E S18.

POTERIDIUM Burnet

Poteridium annuum (Nutt.) Spach GREAT WESTERN BURNET
Common, disturbed areas and roadsides. May-Jul. Beckwourth Sattley Road, T22N R14E S11; Calpine, T21N R14E S16; Antelope Valley, T21N R15E S21; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17 [= *Sanguisorba occidentalis*].

PRUNUS Stone Fruits

Prunus andersonii A. Gray DESERT PEACH
Dry open rocky and sandy slopes. Mar-Apr. Beckwourth Pass, T22N R17E S6; Sugarloaf, T23N R15E S17.

Prunus emarginata (Douglas) Eaton BITTER CHERRY
Rocky openings in conifer forest. Apr-Jun. Sugarloaf, T23N R15E S17; Calpine, T21N R14E S17.

Prunus subcordata Benth. SIERRA PLUM, KLAMATH PLUM
Open rocky areas. Apr-Jun. Reported at Beckwourth Pass, T22N R17E S5; also DS38014, W.R. Dudley, s.n., Aug. 2, 1909, Sierra Valley.

Prunus virginiana L. var. ***demissa*** (Nutt.) Torr. CHOKE CHERRY
Rocky slopes and flats. May-Jun. Newman Point, T21N R14E S25; Sugarloaf, T23N R15E S17.

PURSHIA Bitterbrush

Purshia tridentata (Pursh) DC. var. ***tridentata*** BITTERBRUSH, ANTELOPE BRUSH
Dry slopes and flats. May-Jun. Calpine, T21N R14E S17.

ROSA Rose

Rosa californica Cham. & Schltdl. CALIFORNIA ROSE
Uncommon. Mostly near streams and roadside ditches. May-Aug. Sierraville, T20N R14E S13; Frenchman Lake Road, T23N R16E S10.

Rosa gymnocarpa Nutt. WOOD ROSE
Shaded woodlands and meadow edges. May-Jul. One record for Sierra Valley (CAS74976, Anna Head, s.n., Jun 20, 1921, Campbells Hot Springs, Feather River region). Sierraville, T20N R15E S19.

Rosa woodsii Lindl. var. ***ultramontana*** (S. Wats.) Taylor & MacBryde INTERIOR ROSE
Common, riverbanks and moist places. Jun-Aug. Beckwourth, T23N R14E S27; Antelope Valley, T21N R15E S28; Calpine, T21N R14E S16.

RUBUS Berries

Rubus parviflorus Nutt. THIMBLEBERRY
Open moist woods and canyons. May-Jul. Calpine T21N R14E S18.

SPIRAEA

Spiraea splendens K. Koch MOUNTAIN SPIRAEA
Moist areas in conifer forest. Jun-Sep. To be looked for as this taxon has been collected just to the W of Yuba Pass [= *S. densiflora*].

RUBIACEAE Madder Family

GALIUM Bedstraw, Cleavers

Galium aparine L. GOOSE GRASS, CLEAVERS
Common in moist shaded areas. May-Jul. Sierraville, T20 R14E S15; Sugarloaf, T23N R15E S17; Dyson Lane (S of Hwy 70), T22N R15E S6.

Galium bifolium S. Wats. LOW MOUNTAIN BEDSTRAW
Open to shaded conifer forest. Jun-Sep. To be looked for as this taxon has been reported from just W of Yuba Pass.

Galium bolanderi A. Gray BOLANDER'S BEDSTRAW
Dry rocky slopes. Jun-Aug. Sierraville, T20N R14E S24.

Galium multiflorum Kellogg MANY FLOWERED BEDSTRAW
Uncommon, rocky places in sagebrush. Jun-Aug. Antelope Valley, T21N R15E S16.

Galium trifidum L. var. ***subbiflorum*** (Wieg.) Puff. DWARF TRIFID BEDSTRAW
Infrequent, meadows, streams and other wet places. Jun-Sep. Ramelli Ranch, T23N R14E S27 [*G. t.* var. *pusillum*].

Galium triflorum Michx. FRAGRANT BEDSTRAW
Uncommon, wet meadows and spring areas. Jun-Sep. Calpine, T21N R14E S19.

KELLOGGIA

Kelloggia galioides Torr. KELLOGGIA
Common, dry shaded wooded slopes and flats. May-Jul. Calpine, T21N R14E S19; Sugarloaf, T23N R15E S17.

SALICACEAE Willow Family

POPULUS Cottonwood, Aspen

Populus alba L. WHITE POPLAR, WHITE COTTONWOOD
Common around old homesites. Beckwourth Pass, T22N R17E S6; Sattley, T21N R14E S9.

Populus nigra L. BLACK POPLAR, LOMBARDI POPLAR
Scattered about old homesites. Calpine, T21N R14E S17; Sierraville, T20N R14E S15.

Populus tremuloides Michx. QUAKING ASPEN
Common along streams and wet slopes, especially in the southern end of Sierra Valley. Apr-Jun. Sattley, T20N R14E S9; Chilcoot, T23N R17E S19.

Populus trichocarpa Hook. BLACK COTTONWOOD
Scattered, along stream banks. Sattley, T21N R14E S9; Sierraville, T20N R14E S13 [= *P. balsamifera* subsp. *t.*].

SALIX Willow

Salix boothii Dorn BOOTH'S WILLOW
Wet meadows. Jun-Jul. Loyalton, T21N R15E S12.

Salix breweri Bebb BREWER'S WILLOW
Stream banks in conifer forest. Mar-Apr. To be looked for as this taxon has been collected just northwest of Yuba Pass.

Salix eastwoodiae A. Heller EASTWOOD'S WILLOW, SIERRA WILLOW
Streams and wet meadows. Jun-Jul. Coburn Lake, T20 R14E S29; Yuba Pass, T20N R13E S11.

Salix exigua Nutt. NARROW LEAVED WILLOW, SLENDER WILLOW
Fairly common. Mar-May. Marble Lane, T22N R15E S18; Sugarloaf, T23N R15E S17.

Salix geyeriana Andersson GEYER'S WILLOW
Fairly common, stream sides. Apr-Jun. Loyalton, T21N R15E S13; Calpine, T21N R14E S5.

Salix jepsonii C.K. Schneid. JEPSON'S WILLOW
Damp places. May-Jun. To be looked for as this taxon is found within ½ mi of Yuba Pass.

Salix laevigata Bebb RED WILLOW
Fairly common, around ponds and stream banks. Mar-May. Hwy 49 (S of Vinton), T22N R16E S4.

Salix lasiandra Benth. var. ***caudata*** (Nutt.) Sudw. TAIL-LEAF WILLOW
Infrequent, along stream, lake shores and wet meadows. May-Jun. Frenchman Lake Road, T23N R16E S3.

Salix lasiandra Benth. var. ***lasiandra*** PACIFIC WILLOW
Wet meadows and seepage areas. Mar-May. Sugarloaf, T23N R15E S17; Sierraville, T20N R14E S13.

Salix lasiolepis Benth. ARROYO WILLOW
Common, along streams and other moist places. Mar-Apr. Sugarloaf, T23N R15E S17.

Salix lemmonii Bebb. LEMMON'S WILLOW
Common, meadows, streams and moist places. May-Jun. Sierraville, T20N R14E S13; Sattley, T20N R14E S9.

Salix liguifolia C.K. Schneid. STRAP-LEAFED WILLOW
Fairly common, stream sides. Mar-Jun. Sierraville, T20N R14E S13; Loyalton, T21N R15E S13.

Salix lutea Nutt. YELLOW WILLOW
Uncommon, creek margins and wet meadows. Sugarloaf, T23N R15E S17; Loyalton, T21N R15E S13.

Salix melanopsis Nutt. DUSKY WILLOW
Infrequent, streams and meadows. Mar-May. Ramelli Ranch, T23N R14E S27.

Salix orestera C.K. Schneid. GRAY-LEAFED SIERRA WILLOW
Subalpine meadows and streams. Jun-Jul. To be looked for in the Coburn Lake area.

Salix prolixa Andersson MACKENZIE'S WILLOW
River and stream banks. Mar-Jun. To be looked for as this taxon has been collected all around the Sierra Valley region.

Salix scouleriana Hook. SCOULER'S WILLOW
Frequent, forest openings and not normally along streams. Apr-Jun. Sattley, T21N R14E S32; Loyalton, T21N R15E S13.

SAPINDACEAE Soapberry Family

ACER Maple

Acer glabrum Torr. MOUNTAIN MAPLE
Fairly common on moist shaded slopes. Apr-Jun. Sattley, T21N R13E S25.

SARCOBATACEAE Sarcobatus Family

SARCOBATUS Greasewood

Sarcobatus vermiculatus (Hook.) Torr. GREASEWOOD
Uncommon, subalkaline places. May-Aug. Marble Lane, T22N R15E S18.

SAXIFRAGACEAE Saxifrage Family

LITHOPHRAGMA Woodland Star

Lithophragma affine A. Gray COMMON WOODLAND STAR
Open grassy areas in pine forest. Jun-Jul. Calpine, T21N R14E S19.

Lithophragma glabrum Nutt. SMOOTH WOODLAND STAR
Open dry areas. Apr-May. Beckwourth Sattley Road (S of Beckworth), T22N R14E S11; Yuba Pass, T20N R13E S11; Ramelli Ranch, T23N R14E S26.

Lithophragma parviflorum (Hook.) Torr. & A. Gray var. ***parviflorum*** SMALL FLOWER WOODLAND STAR
Dry sagebrush areas. Apr-Jul. Marble Lane, T22N R14E S13; Calpine, T21N R14E S16.

Lithophragma tenellum Nutt. DAINTY STAR
Open or wooded slopes and sagebrush scrub. May-Jul. Beckwourth Sattley Road (N of Sattley), T21N R14E S28.

MICRANTHES Saxifrage

Micranthes integrifolia (Hook.) Small SMOOTH LEAF SAXIFRAGE
Uncommon in vernally moist areas. Mar-Jun. Calpine, T21N R14E S16 [= *Saxifragia i.*].

Micranthes nidifica (Greene) Small PEAK SAXIFRAGE
Scattered, wet meadow areas, often associated with Carex. Jun-Jul. Knuthson Meadows [= *Saxifragia n. var. n.*].

Micranthes odontoloma (Piper) A. Heller BROOK SAXIFRAGE
Wet stream banks. Jul-Aug. Coburn Lake, T20N R14E S29 [= *Saxifragia o.*].

Micranthes oregana (Howell) Small BOG SAXIFRAGE
Common in wet meadow and fen areas. May-Aug. Sattley, T20N R14E S9 [= *Saxifragia o.*].

PECTIANTIA Miterwort

Pectiantia breweri (A. Gray) Rydb. BREWER'S MITERWORT
Streams and heavily shaded moist areas. Jun-Aug. Yuba Pass, T20N R13E S11 [= *Mitella b.*].

Pectiantia pentandra (Hook.) Rydb. ALPINE MITERWORT
Moist shaded areas. May-Jul. Yuba Pass, T20N R13E S11 [= *Mitella p.*].

SCROPHULARIACEAE Figwort Family

LIMOSELLA Mudwort

Limosella acaulis Sessé. & Moc. SOUTHERN MUDWORT
Uncommon, muddy river edges. May-Oct. Ramelli Ranch, T23N R14E S27.

Limosella aquatica L. NORTHERN MUDWORT
Muddy stream and shore edges. Jun-Sep. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Beckwourth, T23N R14E S26.

Limosella australis R. Br. DELTA MUDWORT
Roadside ditches and mud flats. May-Sep. One collection for Sierra Valley (SJSU14242, N.A. Hopkins, W. Anderson, #1499, May 27, 1989). Dyson Lane (S of Beckwourth), T22N R15E S8.

SCROPHULARIA Figwort

Scrophularia desertorum (Munz) R.J. Shaw DESERT FIGWORT
Fairly common, dry slopes and cliffs. Jun-Aug. Vinton, T23N R16E S35; Frenchman Lake Road, T23N R16E S3; Sugarloaf, T23N R15E S17.

Scrophularia lanceolata Pursh MOUNTAIN FIGWORT
Uncommon, moist stream banks and meadows. One record for Sierra Valley (CDA11872, G.F. Hrusa & J. Jokerst, #8533A, Jul 5, 1991). May-Jul. Antelope Valley, T21N R15E S34.

VERBASCUM Mullein

Verbascum thapsus L. COMMON MULLEIN
Common, disturbed areas and roadsides. Jun-Sep. Calpine, T21N R14E S16; Sugarloaf, T23N R15E S17.

SOLANACEAE Nightshade Family

CHAMAESARACHA

Chamaesaracha nana (A. Gray) A. Gray DWARF CHAMAESARACHA
Common, sandy slopes and flats. May-Jul. Calpine, T21N R14E S16.

LYCIUM Wolf Berry

Lycium barbarum L. MATRIMONY VINE, WOLF BERRY
Two historical records for Sierra Valley; UC1714337, *Lycium halimifolium*, H.M. Hall & E.B. Babcock, #4462, Jul 1903, Beckwourth, T23N R14E S26 & RENO37488, Helen Hamlin, #1522, Jul 1904, Sierra Valley (probably in the Sierraville area as the Hamlin family ranched in this area).

NICOTIANA Tobacco

Nicotiana attenuata S. Wats. COYOTE TOBACCO
Common, disturbed sandy areas. May-Oct. Calpine, T21N R14E S16; Beckwourth Pass, T22N R17E S6.

Nicotiana langsdorffii Weinm. LANGSDORFF'S TOBACCO
Cultivated plant, primarily horticultural (J.G. Lemmon s.n., Sierraville, no date; bar code: P00455048, Herbier Museum Paris).

SOLANUM Nightshade

Solanum physalifolium Rusby var. *nitidibaccatum* (Bitter) Edmonds HAIRY NIGHTSHADE
Uncommon, along roads, sand and gravel bars along rivers. May-Nov. Frenchman Lake Road, T23N R16E S11 [= *S. sarrachoides*].

Solanum rostratum Dunal BUFFALO BURR
Rare, generally a waif from bird seed. May-Sep. Calpine, T21N R14E S16.

Solanum triflorum Nutt. CUTLEAF NIGHTSHADE
Dry sagebrush scrub. Jul-Aug. Sierraville, T20N R14E S13; Loyalton, T21N R15E S13.

URTICACEAE Nettle Family

URTICA Stinging Nettle

Urtica dioica L. STINGING NETTLE
Uncommon in moist areas. Jun-Sep. This taxon has been reported from the Antelope Valley area but there are no confirmed records for the Sierra Valley region.

VALERIANACEAE Valerian Family

PLECTRITIS

Plectritis ciliosa (Greene) Jeps. subsp. ***insignis*** (Suksd.) Morey LONG SPURRED PLECTRITIS
Partly shaded slopes. Apr-Jun. Ramelli Ranch, T23N R14E S28.

Plectritis congesta (Lindl.) DC subsp. ***brachystemon*** (Fisch. & C.A. Mey.)Morey SEA BLUSH
Uncommon, sandy areas. Apr-Jun. Beckwourth Pass, T22N R17E S5.

Plectritis macrocera Torr. & A. Gray WHITE PLECTRITIS
Common, moist shady areas of pines and sagebrush. May-Jul. Calpine, T21N R14E S16; Loyalton, T21N R15E S15; Hwy 70 (The Buttes), T23N R15E S28.

VALERIANA Valerian

Valeriana californica A. Heller CALIFORNIA VALERIAN
Locally common, moist open or wooded slopes. Jul-Aug. Yuba Pass (S of), T20N R13E S14; Coburn Lake, T20N R14E S29.

VERBENACEAE Vervain Family

VERBENA Vervain
Verbena bracteata Lag. & Rodr. BRACTED VERVAIN
Limited, disturbed areas and road and pond shores. May-Oct. Dyson Lane, T22N R15E S13; Sattley, T20N R14E S9.

VIOLACEAE Violet Family

VIOLA Violet

Viola adunca Sm. subsp. ***adunca*** BLUE VIOLET
Moist, generally shaded areas. Apr-Aug. One record for the Sierra Valley area (POM286609, Mrs. J.W. Morrison, s.n., Loyalton). Loyalton, T21N R15E S13.

Viola bakeri Greene BAKER'S VIOLET
Fairly common, wooded slopes and flats. May-Aug. Yuba Pass, T20N R13E S11.

Viola beckwithii Torr. & A. Gray GREAT BASIN VIOLET
Common, sagebrush flats and slopes. Mar-May. Calpine, T21N R14E S16; Newman Point, T21N R14E S25; Ramelli Ranch, T23N R14E S27.

Viola glabella Nutt. STREAMSIDE VIOLET, SMOOTH YELLOW VIOLET
Streams and moist shaded areas. Apr-Jul. Sattley, T20N R14E S9; Sierraville, T20N R14E S15.

Viola macloskeyi F.E. Lloyd MACLOSKEY'S VIOLET
Common, seep areas and wet meadows. May-Aug. Sattley, T20N R14E S9.

Viola nephrophylla Greene LECONTE VIOLET
Uncommon, shaded swampy areas. Apr-Aug. Sattley, T20N R14E S9; Corecco Canyon, T22N R16E S27.

Viola pinetorum Greene subsp. ***grisea*** (Jeps.) R.J. Little GRAY-LEAVED VIOLET
Infrequent, openings in woods. Jun-Aug. Yuba Pass, T20N R13E S11.

Viola pinetorum Greene subsp. ***pinetorum*** PINE VIOLET
Frequent, openings in woods. Jun-Aug. Ross Meadows, T23N R14E S33; Calpine, T21N R14E S29.

Viola praemorsa Lindl. subsp. ***linguifolia*** (Nutt.) M.S. Baker & J.C. Clausen UPLAND YELLOW VIOLET
Moist forest floors. Jun-Aug. Loyalton, T21N R16E S8.

Viola praemorsa Lindl. subsp. ***praemorsa*** ASTORIA VIOLET
Vernally moist areas. Apr-Jul. One collection for Sierra Valley (UC337759, J.G. Lemmon, #48, Jun, 1874, Sierra Valley).

Viola purpurea Kellogg subsp. ***aurea*** (Kellogg) J.C. Clausen GOLDEN VIOLET
Rare, sagebrush and sandy slopes. CRPR 2B. Apr-Jun. Beckwourth Sattley Road, T22N R14E S34; Sattley, T20N R14E S9.

Viola purpurea Kellogg subsp. ***integrifolia*** M.S. Baker & J.C. Clausen SMOOTH LEAVED VIOLET
Red fir forest. May-Aug. To be looked for in the higher elevations.

Viola purpurea Kellogg subsp. ***purpurea*** MOUNTAIN VIOLET
Common, dry slopes and woods. May-Aug. Hwy 89 (N of Sattley), T21N R14E S32; Knuthson Meadows, T21N R14E S5.

Viola purpurea Kellogg subsp. ***quercetorum*** (M.S. Baker & J.C. Clausen) R.J. Little GOOSE FOOT VIOLET
Dry slopes and woods. May-Aug. One record for the Sierra Valley area (UC338299, unknown, 20 May 1887, Specimen separated from sheet no. 564992; from the Lemmon Herbarium).

Viola purpurea Kellogg subsp. ***venosa*** (S. Wats.) M.S. Baker & J.C. Clausen DESERT VIOLET
Common, dry sandy slopes and flats. Apr-Jul. Frenchman Lake Road, T23N R16E S25; Hwy 70 (The Buttes), T23N R15E S28; Vinton, T23N R16E S21.

Viola sheltonii Torr. SHELTON'S VIOLET
Pine and fir forests. Apr-Jul. One record for the Sierra Valley region (POM286463, Mrs. J.W. Morrison s.n., no date, Loyalton). To be looked for in the Yuba Pass area as this taxon has been reported just to the west.

VISCACEAE Mistletoe Family

PHORADENDRON Mistletoe

Phoradendron juniperinum A. Gray JUNIPER MISTLETOE, INCENSE CEDAR MISTLETOE
Fairly common. Hwy 49 (W of Sattley), T21N R14E S31 [= *P. libocedri*].

ZYGOPHYLLACEAE Caltrop Family

TRIBULUS Puncture Vine

Tribulus terrestris L. PUNCTURE VINE
Uncommon, disturbed areas. Apr-Oct. Loyalton, T21N R15E S13.

MONOCOTS

AGAVACEAE

CAMASSIA Camas

Camassia leichtlinii (Baker)S. Wats. subsp. ***suksdorfii*** (Greenm.) Gould LARGE FLOWERED CAMAS
Common, wet to drying meadows. May-Jun. Calpine, T21N R14E S16; Sierraville, T20N R14E S13 [= *C. quamash* subsp. *q.*].

Camassia quamash (Pursh) Greene subsp. ***breviflora*** Gould SMALL FLOWERED CAMAS
Limited, wet meadows. May-Jul. Yuba Pass, T20N R13E S11; Knuthson Meadows, T21N R14E S5; Beckwourth Sattley Road, T22N R14E S26 [= *C. q.* subs. *linearis*].

HASTINGSIA

Hastingsia alba (Durand) S. Wats. WHITE FLOWERED HASTINGSIA
Meadows, swampy places and rocky seeps. Jun-Jul. One record for Sierra Valley (UC 367064, Jul 1874, Unknown. Date as "Jul, 1874." From Lemmon Herbarium, probably collected by Lemmon).

LEUCOCRINUM Sand Lily

Leucocrinum montanum A. Gray SAND LILY
Uncommon, sandy flats, often in the sagebrush. Apr-May. Dyson Lane, T22N R16E S17; Calpine, T21N R14E S16.

ALISMATACEAE Water Plantain Family

ALISMA Water Plantain

Alisma triviale Pursh COMMON WATER PLANTAIN
Scattered, roadside ditches. Jun-Aug. Marble Lane, T22N R15E S18.

DAMASONIUM

Damasonium californicum Benth. FRINGED WATER PLANTAIN
Scattered on drying riverbanks and roadside ditches. May-Aug. Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R14E S13.

SAGITTARIA Tule Potato, Arrowhead

Sagittaria cuneata E. Sheld. ARUM-LEAVED ARROW-HEAD
Uncommon in marsh areas and ponds. Jun-Aug. Marble Lane T22N R15E S17; Calpine, T21N R14E S16 (plants at this site have not been seen since 1996).

ALLIACEAE

ALLIUM Onion

Allium amplectens Torr. NARROW LEAVED ONION
Vernally moist slopes. Apr-Jun. Hwy 70 (E of The Buttes), T23N R15E S35.

Allium anceps Kellogg KELLOG'S ONION
Drying slopes and flats. Apr-Jun. Beckwourth Sattley Road, T22N R14E S11 & S23.

Allium bisceptrum S. Wats. TWIN CRESTED ONION
Local, meadows and aspen groves. Jun-Jul. Frenchman Lake Road, T23N R16E S30; Beckwourth Sattley Road, T22N R14E S13.

Allium campanulatum S. Wats. SIERRA ONION
Common, dry wooded slopes and flats. May-Jul. Calpine, T21N R14E S16.

Allium lemmonii S. Wats. LEMMON'S ONION
Common, drying slopes and flats. May-Jun. Calpine, T21N R14E S16; Marble Lane, T22N R15E S18; Newman Point, T21N R14E S25; Sierraville, T20N R15E S18; Ramelli Ranch, T23N R14E S28.

Allium parvum Kellogg DWARF ONION
Common, rocky slopes and volcanic scalds. May-Jul. Calpine, T21N R14E S16; Sattley, T21N R14E S28.

Allium platycaule S. Wats. FLAT STEMMED ONION
Local, open gravelly ridges, slopes and volcanic scalds. May-Jul. Mapes Canyon, T23N R14E S11; Beckwourth Sattley Road, T22N R14E S23.

Allium validum S. Wats. SWAMP ONION
Wet meadows and seeps. Jul-Sep. To be looked for in the Yuba Pass area.

ARACEAE Arum Family

LEMNA Duckweed

Lemna gibba L. GIBBOUS DUCKWEED
Local, fresh or brackish water. Loyalton, T21N R15E S13.

Lemna minor L. LEAST DUCKWEED
Fairly frequent, slow moving fresh water. Marble Lane, T22N R14E S13; Ramelli Ranch, T23N R14E S28; Loyalton, T21N R15E S14.

Lemna minuta Kunth MINUTE DUCKWEED
Fairly common, slow moving fresh water. Antelope Valley, R21N R15E S17 [= *L. minuscule*].

Lemna trisulca L. IVY LEAVED DUCKWEED
Mountain streams and meadows. Generally forming tangled masses below the water surface. To be looked for in the project area.

Lemna turionifera Landolt BUDDED DUCKWEED
Uncommon. Fresh water. "Island School House"; either Loyalton, T21N R15E S13 or Dyson Lane, T22N R16E S13 (depending on the date the school house was moved to its present site in Loyalton).

Lemna valdiviana Phil. DUCKWEED
Fairly common, fresh water. Sierraville, T20N R15E S18.

SPIRODELA Great Duckweed or Duckmeat

Spirodela polyrhiza (L.) Schleid. COMMON DUCKMEAT
Fairly common in fresh water, but rarely collected. Heriot Lane, T22N R15E S33.

CYPERACEAE Sedge Family

BOLBOSCHOENUS Tuberous Bulrush

Bolboschoenus fluviatilis (Torr.) Sojak RIVER BULRUSH
Uncommon in California. Fresh water marshes and ponds. Jun-Sep. To be looked for as this taxon has been collected at Portola just W of the Sierra Valley area.

CAREX Sedge

Carex abrupta Mack. ABRUPTLY BEAKED SEDGE
Fairly common, dryer meadows and open slopes. Yuba Pass, T20N R13E S11. Also found just to the W of project at McNair Meadows, T21N R13E S14.

Carex amplifolia Boott BIG-LEAF SEDGE
Wet soils of creeks and meadows. May-Sep. One collection for Sierra Valley (DS64170, J.G. Lemmon, s.n., Sierra Valley. Olsen's Ranch). Sierraville, T20N R14E S13.

Carex angustata Boott NARROW-LEAVED SEDGE
Stream banks and wet meadows. Jun-Sep. To be looked for in the higher elevations as this taxon has been reported just to the W of Yuba Pass.

Carex aquatilis Wahlenb. var. ***aquatilis*** WATER SEDGE
Wet places and marshy meadows. Jul-Sep. Sugarloaf, T23N R15E S17.

Carex athrostachya Olney SLENDER BEAKED SEDGE
Streams, seeps and other wet areas. May-Sep. Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S29.

Carex aurea Nutt. GOLDEN FRUITED SEDGE
Wet meadows and seeps. Jun-Aug. Marble Lane, T22N R15E S18.

Carex brainerdii Mack. BRAINERD'S SEDGE
Open forest and dry rocky areas. May-Jul. To be looked for in the higher elevations as this taxon has been reported from just W of Yuba Pass.

Carex capitata L. CAPITATE SEDGE
Moist alpine meadows and peat bogs. Jul-Sep. To be looked for as this taxon has been collected just outside the project area to the S of Yuba Pass.

Carex cusickii Piper & Beattie CUSICK'S SEDGE
Wet meadows, bogs and marshes. Jun-Sep. To be looked for in the Calpine area as this taxon is found just to the W at McNair Meadows (T21N R13E S14).

Carex diandra Schrank LESSER TUSSOCK SEDGE
Marshy meadows and terrestrial fens. Jul-Aug. Maiden Valley, T20N R14E S29.

Carex douglasii Boott DOUGLAS' SEDGE
Dry mountain meadows, sagebrush flats. May-Aug. Sugarloaf, T23N R15E S17; Ramelli Ranch, T23N R14E S27; Calpine, T21N R14E S16.

Carex echinata Murray subsp. ***echinata*** STAR SEDGE
Wet places and bogs. Jun-Sep. To be looked for as this taxon has been reported just to the W of Yuba Pass.

Carex feta L.H. Bailey GREEN-SHEATHED SEDGE
Wet meadows and seeps. May-Aug. To be looked for as this taxon is found just to the W of Yuba Pass.

Carex filifolia Nutt. var. ***erostrata*** Kük. SAGEBRUSH SEDGE
Common, dry open flats and slopes. May-Aug. Beckwourth Sattley Road, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

Carex filifolia Nutt. var. ***filifolia*** THREAD-LEAVED SEDGE
Common, dry open flats and slopes. Jul-Aug. Calpine, T21N R14E S16.

Carex fissuricola Mack. CANYON SEDGE
Meadows and rocky stream sides. Jul-Sep. To be looked for as this taxon has been found on Sulphur Creek, within 2 mi of the project area and at Haskell Peak.

Carex fracta Mack. FRAGILE SHEATHED SEDGE
Montane meadows, open forest. May-Sep. Calpine, T21N R14E S30.

Carex hassei L.H. Bailey HASSE'S SEDGE
Springs, fens and wet meadows. May-Sep. One collection for Sierra Valley (CAS102960, Lemmon, #487, Sep. 1874, Sierra Valley).

Carex heteroneura W. Boott SMOOTH-FRUITED SEDGE
Rocky slopes, forest openings and meadows. Jun-Sep. To be looked for as this taxon has been found on Sulphur Creek, just W of the project, and to the S of Yuba Pass

Carex hoodii Boott HOOD'S SEDGE
Fairly common, meadow edges and rocky slopes. Jun-Sep. Hwy 89 (Calpine Summit), T22N R13E S13.

Carex illota L.H. Bailey SMALL HEADED SEDGE
Montane wet meadows and bogs, usually above 6500 feet. Jul-Sep. To be looked for in the Yuba Pass area as this taxon has been collected just to the west.

Carex jonesii L.H. Bailey JONES' SEDGE
Moist places, meadows and streams. Jun-Sep. Sattley, T20N R14E S9.

Carex lemmonii W. Boott LEMMON'S SEDGE
Spring areas and moist meadows. May-Aug. To be looked for as this taxon has been reported from just W of Yuba Pass.

Carex lenticularis Michx. LAKESHORE SEDGE
Wet meadows and lake shores. Jun-Oct. To be looked for in the higher elevations especially in the area of Coburn Lake. This taxon has been reported from just W of Yuba Pass.

Carex luzulifolia W. Boott LITTLE-LEAVED SEDGE
Uncommon, usually above 7000', wet meadows and wet rocky slopes. Jul-Sep. Coburn Lake, T20N R14E S29.

Carex mariposana Mack. MARIPOSA SEDGE
Dry slopes and meadows. Jun-Aug. To be looked for as this taxon has been collected just W of Yuba Pass.

Carex microptera Mack. SMALL-WINGED SEDGE
Meadows and open slopes. Jun-Aug. To be looked for as this taxon has been reported from just W of Yuba Pass.

Carex multicaulis L.H. Bailey MANY STEMMED SEDGE
Common, rocky slopes and open woods. Apr-Jul. One collection listed for Sierra Valley, (UC825435, J.G. Lemmon s.n., 1882).

Carex multicostata Mack. MANY RIBBED SEDGE
Dry meadows and open woods. Jul-Sep. To be looked for as this taxon is found within 1 mi of the N boundary of the project area and also just W of Yuba Pass.

Carex nebrascensis Dewey NEBRASKA SEDGE
Common, wet meadows and roadside ditches. Jun-Sep. Antelope Valley, T21N R15E S21; Sattley, T20N R14E S9.

Carex nervina L. Bailey SIERRA SEDGE
Meadows, streams and springs. Jun-Sep. To be looked for as this taxon is found on Sulphur Creek, just W of project area, and just W of Yuba Pass.

Carex nudata W. Boott TORRENT SEDGE
Uncommon, rocky streams and rivers. Apr-Jul. Grizzly Creek (W of the Lester Davis Rest Area on Hwy 70), T23N R14E S28.

Carex pellita Muhl. ex Willd. WOOLY SEDGE
Generally marshy places and stream banks. May-Sep. One record for Sierra Valley (CAS103093, Alice Eastwood, #7019, Jun 29, 1918, Loyalton).

Carex praegracilis W. Boott CLUSTERED FIELD SEDGE
More or less moist places, often alkaline. Apr-Aug. Sugarloaf, T23N R15E S17; Marble Lane, T22N R15E S18.

Carex raynoldsii Dewey RAYNOLDS' SEDGE
Common, meadows. Jun-Aug. Yuba Pass, T20N R13E S11.

Carex rossii Boott ROSS' SEDGE
Dry meadows and slopes. May-Aug. Sugarloaf, T23N R15E S17.

Carex scopulorum T. Holm var. ***bracteosa*** (L.H. Bailey) F.J. Herm. SIERRA ALPINE SEDGE
Limited, wet meadows and swamps. Jul-Sep. Coburn Lake, T20N R14E S29.

Carex simulata Mack. SHORT-BEAKED SEDGE
Wet meadows and fen like places. Jun-Sep. Sattley, T21N R14E S33; Sierraville, T20N R14E S13.

Carex specifica L.H. Bailey NARROW-FRUITED SEDGE
Dry meadows and forest openings. Jul-Sep. To be looked for as this taxon has been collected to the W of Yuba Pass.

Carex spectabilis Dewey SHOWY SEDGE
Limited, usually above 6000', wet meadows and seeps below lingering snowbanks. Jul-Sep. Coburn Lake, T20N R14E S29.

Carex stipata Willd. var. ***stipata*** AWL FRUITED SEDGE
Wet areas about lakes, streams and seeps. May-Aug. One record for Sierra Valley (UC835954, J.G. Lemmon, #479, Sierra Valley).

Carex straminiformis L.H. Bailey MOUNT SHASTA SEDGE
Usually above 6500', rocky or gravelly soils. Jul-Sep. To be looked for as this taxon is found just to the W of Yuba Pass.

Carex subfusca W. Boott SIERRA SLENDER SEDGE
Fairly common, drier portions of meadows, edges of woods and open woodland floors. May-Sep. Sugarloaf, T23N R15E S17; Yuba Pass, T20N R13E S11; Sattley, T21N R14E S31.

Carex utriculata Boott BEAKED SEDGE
Common, lake shores, marsh areas and standing water of slow moving streams. Jun-Sep. Sattley, T20N R14E S9.

Carex vesicaria L. INFLATED SEDGE
Wet places and shallow water. Jun-Sep. One record for Sierra Valley (DS64026, J.G. Lemmon, s.n., Sep. 1875, Sierra Valley).

Carex whitneyi Olney WHITNEY'S SEDGE
Common, open wooded slopes and dry gravelly meadows. Jun-Aug. Yuba Pass, T20N R13E S11.

CYPERUS Nutsedge

Cyperus squarrosus L. BEARDED FLAT SEDGE
Marsh areas and ponds. Jun-Nov. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27.

ELEOCHARIS Spike Rush

Eleocharis bella (Piper) Svenson ANNUAL NEEDLE SPIKE RUSH
Wet soils in sagebrush scrub and lodgepole pine stands. Spring-Summer. Ramelli Ranch, T23N R14E S27 [= *Eleocharis acicularis* var. *b.*].

Eleocharis engelmannii Steud. var. ***detonsa*** A. Gray ENGELMANN'S SPIKE RUSH
Uncommon, wet soils of pond and lake margins. Spring-Fall. Calpine, T21N R14E S16 [= *Eleocharis obtusa* var. *e.*].

Eleocharis macrostachya Britton CREEPING SPIKE RUSH
Common, ponds, ditches and marshes. Spring-Summer. Marble Lane, T22N R15E S18.

Eleocharis montevidensis Kunth SAND SPIKE RUSH
Locally common, seasonally wet zones. Spring-Summer. Marble Lane, T22N R15E S18; Calpine, T21N R14E S16.

Eleocharis palustris (L.) Roem. & Schult. COMMON SPIKE RUSH
Common, wet meadows and ponds. Summer. Yuba Pass, T20N R13E S11; Sierraville, T20N R15E S19.

Eleocharis parishii Britton PARISH'S SPIKE RUSH
Streams and ponds. Late spring-Fall. Reported from just W of Yuba Pass.

Eleocharis quinqueflora (Hartmann) O. Schwarz FEW FLOWERED SPIKE RUSH
Uncommon, wet meadows, fens and seeps. Spring-Summer. Sugarloaf, T23N R15E S17.

Eleocharis rostellata (Torr.) Torr. WALKING SEDGE
Springs and hot springs. Spring-Summer. Two records for Sierra Valley, both at the same locality (DS55462 & DS55464; Near east hot spring, Sierra Valley). Sierraville, T20N R15E S19.

Eleocharis suksdorfiana Beauverd SUKSDORF'S SPIKE RUSH
Wet meadows and fens. Summer. Sattley, T20N R14E S9.

ERIOPHORUM Cottongrass

Eriophorum criniger (A. Gray) Beetle FRINGED COTTONGRASS
Wet montane meadows. Jun-Aug. To be looked for as this taxon has been collected just W of Yuba Pass [= *Eriophorum crinigerum*].

Eriophorum gracile Roth SLENDER COTTONGRASS
Wet meadows and bogs. CRPR 4. May-Jul. Maiden Valley, T20N R13E S29.

KOBRESIA Bog Sedge

Kobresia myosuroides (Vill.) Fiori & Paol BELLARDI BOG SEDGE
Rare, drying vernal meadows. CRPR 2B. Jun-Aug. Calpine, T21N R14E S9 & S15.

SCHOENOPLECTUS Naked-Stemmed Bulrushes

Schoenoplectus acutus (Bigelow) A.&D. Love var. ***occidentalis*** (S. Wats.) S.G. Sm. HARDSTEM BULRUSH
Common, marshy areas and wet ditches. Summer. Marble Lane, T22N R15E S18 [= *Scripus a.* var. *a.*].

Schoenoplectus americanus (Pers.) Schinz & R. Keller THREE SQUARE
Fairly common, marshes and ponds. Summer. Ramelli Ranch, T23N R14E S26; Marble Lane, T22N R14E S13 [= *Scirpus a.*].

Schoenoplectus pungens (Vahl) Palla var. ***longispicatus*** (Britton) S.G. Sm. COMMON THREE SQUARE
Limited, subalkaline meadows and hot wells. Late spring-Summer. Marble Lane, T22N R14E S13 [= *Scirpus p.*].

SCIRPUS Bulrush or Tule

Scirpus congdonii Britton CONGDON'S BULRUSH
Meadows and stream banks. Jul-Aug. To be looked for in higher elevation wet meadows near Yuba Pass as this taxon has been collected just to the west.

Scirpus microcarpus J. Presl. & C. Presl SMALL FRUITED BULRUSH
Along streams, springs and wet meadows. Jun-Jul. Sierraville, T20N R15E S18; Calpine, T21N R14E S19; Sugarloaf, T23N R15E S17.

HYDROCHARITACEAE Waterweed Family

ELODEA Waterweed

Elodea canadensis Michx. COMMON WATERWEED
Marshlands. Jul-Aug. Ramelli Ranch (E of Co. Rd. A-23), T23N R14E S35.

Elodea nuttallii (Planch.) H. St. John NUTTALL'S WATERWEED
Uncommon, slow moving streams and ponds. Jul-Aug. Ramelli Ranch, T23N R14E S27; Sattley, T21N R14E S28; Marble Lane, T22N R15E S17.

IRIDACEAE Iris Family

IRIS Iris

Iris missouriensis Nutt. WESTERN BLUE FLAG
Common, drying meadows and flats. May-Jul. Marble Lane, T22N R15E S18; Sierraville, T20N R14E S13.

SISYRINCHIUM Eyed grass

Sisyrinchium bellum S. Wats. CALIFORNIA BLUE EYED GRASS
Uncommon, moist open meadows. Apr-Jun. Dyson Lane (S of Hwy 70), T23N R15E S31.

Sisyrinchium halophilum Greene NEVADA BLUE EYED GRASS
Uncommon, generally moist alkaline meadows. May-Jun. Sattley, T20N R14E S4; Marble Lane, T22N R15E S17.

Sisyrinchium idahoense E.P. Bicknell var. ***occidentale*** (E.P. Bicknell) Douglass M. Hend. WESTERN BLUE EYED GRASS
Frequent, wet meadows. Jun-Aug. Marble Lane, T22N R15E S18; Calpine, T21N R14E S19; Beckwourth Sattley Road, T21N R14E S4; Sugarloaf, T23N R15E S17.

JUNCACEAE Rush Family

JUNCUS Wire Grass, Rush

Juncus balticus Willd. subsp. ***ater*** (Rydb.) Snogerup BALTIC RUSH
Fairly common, wet areas. Jul-Nov. Sattley, T20N R14E S9; Calpine, T21N R14E S16; Marble Lane, T22N R15E S13.

Juncus bryoides F.J. Herm. MINUTE RUSH, MOSS RUSH
Infrequent, moist sandy ditches and about seeps. May-Jun. Marble Lane, T22N R14E S13.

Juncus bufonius L. var. ***bufonius*** COMMON TOAD RUSH
Common, vernally moist places, pools and sandbars. Apr-Sep. Marble Lane, T22N R14E S13; Ramelli Ranch, T23N R14E S27.

Juncus bufonius L. var. ***occidentalis*** F.J. Herm. ROUND FRUITED TOAD RUSH
Fairly common, vernally moist swales and muddy places. Apr-Sep. Knuthson Meadows, T21N R14E S5; Beckwourth Sattley Road (near Calpine), T21N R14E S15.

Juncus chlorocephalus Engelm. GREEN HEADED RUSH
Limited, meadows and seeps. Jul-Sep. To be looked for as this taxon is found on Sulphur Creek just to the W of project area.

Juncus confusus Coville COLORADO RUSH
Meadows in conifer forests. Jul-Sep. To be looked for in the Yuba Pass area as this taxon has been collected just to the west.

Juncus covillei Piper COVILLE'S RUSH
Montane forest. Jul-Sep. To be looked for as this taxon has been collected near Yuba Pass.

Juncus dubius Engelm. MARIPOSA RUSH
Wet areas. Jul-Sep. To be looked for as this taxon has been collected in the Sulphur Creek area just to the W of the project area.

Juncus effusus L. subsp. ***pacificus*** (Fernald & Wieg.) Piper & Beattie COMMON BOG RUSH
Wet seeps, damp sunny ground. May-Oct. Lemmon Canyon (Sierraville), T20N R15E S16.

Juncus ensifolius Wikstr. SWORDLEAF RUSH
Common, wet places. Jul-Sep. Frenchman Lake Road, T23N R16E S11; Coburn Lake, T20N R14E S29.

Juncus hemiendytus F.J. Herm. var. ***abjectus*** (F.J. Herm.) Ertter LEAST DWARF RUSH
Limited, vernally wet areas. CRPR 4. May-Jul. Ramelli Ranch, T23N R14E S26.

Juncus hemiendytus F.J. Herm. var. ***hemiendytus*** HERMANN'S DWARF RUSH
Fairly common, vernally moist areas. Apr-Jul. Ramelli Ranch, T23N R14E S27.

Juncus howellii F.J. Herm. HOWELL'S RUSH
Fairly common, meadows. Jul-Aug. To be looked for as this taxon has been reported from Sulphur Creek just W of the project area.

Juncus luciensis Ertter SANTA LUCIA DWARF RUSH
Vernally moist sands and along streams. CRPR 1B. May-Jun. Ramelli Ranch, T23N R14E S27.

Juncus macrandrus Coville LONG ANTHERED RUSH
Infrequent, meadows, seeps and stream banks. Jul-Aug. Ramelli Ranch, T23N R14E S27.

Juncus mertensianus Bong. MERTEN'S RUSH
Common, usually above 5000', wet meadows and stream banks. Jul-Aug. Coburn Lake, T20N R14E S20.

Juncus mexicanus Willd. MEXICAN RUSH
Fairly common, meadows. Aug-Nov. Vinton, T23N R16E S33.

Juncus nevadensis S. Wats. var. ***nevadensis*** NEVADA RUSH
Fairly common, wet meadows and stream banks. Jul-Aug. Sierraville, T20N R14E S13.

Juncus occidentalis (Coville) Wieg. WESTERN RUSH
Fairly frequent, vernally moist areas. Apr-Jul. Mapes Canyon, T23N R14E S11.

Juncus orthophyllus Coville STRAIGHT LEAVED RUSH
Common, wet meadows and stream banks. Jul-Aug. Calpine, T21N R14E S19; Yuba Pass, T20N R13E S11.

Juncus oxymeris Engelm. POINTED RUSH
Along streams and other wet places. Jun-Aug. To be looked for in the Yuba Pass area as this taxon has been collected just to the west.

Juncus parryi Engelm. PARRY'S WIRE GRASS
Common, dry rocky slopes. Jul-Aug. Coburn Lake, T20N R14E S20.

Juncus tenuis Willd. POVERTY OR SLENDER RUSH
Moist meadow areas. Jun-Sep. To be looked for in the Yuba Pass area as this taxon has been collected just to the west.

Juncus tiehmii Ertter TIEHM'S DWARF RUSH
Uncommon, vernally moist swales and ditches. May-Jun. Marble Lane, T22N R14E S13.

Juncus uncialis Greene INCH HIGH DWARF RUSH
Limited, vernally moist roadside ditches and low depressions. May-Jun. Marble Lane, T22N R14E S13.

Juncus xiphiodes E. Mey. IRIS LEAVED RUSH
Wet places. Jul-Oct. This taxon has been reported just to the W of Yuba Pass.

LUZULA Wood Rush

Luzula comosa E. Mey. var. ***comosa*** COMMON WOOD RUSH
Frequent, open woods and meadows. May-Aug. Sattley, T20N R14E S9.

Luzula divaricata S. Wats. FORKED WOOD RUSH
Subalpine forests and granitic slopes. Jun-Jul. To be looked for in the Yuba Pass and Coburn Lake areas as this taxon has been collected just to the west.

Luzula parviflora (Ehrh.) Desv. SMALL FLOWERED WOOD RUSH
Stream banks and springs. Jun-Aug. This taxon has been reported from just W of the Yuba Pass area.

Luzula spicata (L.) DC. SPIKED WOOD RUSH
Subalpine moist to wet places. Jul-Aug. This taxon has been reported just W of Yuba Pass.

Luzula subcongesta (S. Wats.) Jeps. DONNER WOOD RUSH
Local, usually above 6200', springs, seeps and stream banks. Jul-Aug. Coburn Lake, T20N R13E S25; Yuba Pass, T20N R13E S11.

JUNCAGINACEAE Arrow Grass Family

TRIGLOCHIN Arrow Grass

Triglochin maritima L. SLENDER ARROW GRASS
Alkaline meadows. Apr-Aug. Sattley, T21N R14E S28.

Triglochin scilloides (Poir.) Hauman FLOWERING QUILLWORT
Limited, marshy and muddy places. May-Jul. Marble Lane, T22N R14E S13; Ramelli Ranch; T23N R14E S27; Calpine, T21N R14E S16 [= *Lilaea s.*].

LILIACEAE Lily Family

CALOCHORTUS Star Tulip

Calochortus bruneanis A. Nels. & J.F. Macbr. GREAT BASIN MARIPOSA LILY
Very limited, slopes in sagebrush. May-Aug. Sugarloaf, T23N R15E S17.

Calochortus leichtlinii Hook. f. SIERRA MARIPOSA LILY
Common, sagebrush flats and open woods. May-Sep. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S19.

ERYTHRONIUM Fawn Lily

Erythronium purpurascens S. Wats. FAWN LILY
Open forested or brushy slopes following melting snow banks. Apr-Jul. To be looked for in the Yuba Pass and Lincoln Ridge areas.

FRITILLARIA Fritillary

Fritillaria atropurpurea Nutt. PURPLE FRITILLARY
Fairly common, open to wooded slopes. May-Jul. Calpine, T21N R14E S16; Sierraville, T20N R14E S24.

Fritillaria pudica (Pursh) Spreng. YELLOW BELLS
Very common, sagebrush scrub and open wooded slopes. Mar-Jun. Calpine, T21N R14E S16; Newman Point, T21N R14E S25; Hwy 70 (The Buttes), T23N R15E S28; Dyson Lane (S of Hwy 70), T22N R15E S6.

Fritillaria recurva Benth. SCARLET FRITILLARY
Fairly common, dry woodlands. Apr-Jun. Sattley, T21N R14E S31; Ross Meadows, T23N R14E S33; Calpine, T21N R14E S17.

LILIUM Lily

Lilium pardalinum Kellogg subsp. ***pardalinum*** TIGER LILY
Hillside seeps, wet thickets and stream sides. May-Aug. Sattley, T20N R14E S9.

Lilium parvum Kellogg ALPINE LILY
Wet meadows and willow thickets. Jun-Aug. No known collections from the project area, but this taxon has been reported just to the south near Sardine Peak and also collected near Webber Lake. To be looked for in the higher elevations of project area.

Lilium washingtonianum Kellogg subsp. ***washingtonianum*** WASHINGTON LILY
Fairly common, brushy slopes. Jun-Aug. Sattley, T20N R14E S4; Sierraville, T20N R14E S13; Calpine, T21N R14E S18.

MELANTHIACEAE

TOXICOSCORDION Death Camas

Toxicoscordion paniculatus (Nutt.) S. Wats. SAND CORN
Common, open areas in sagebrush and woods. May-Jun. Calpine, T21N R14E S16; Frenchman Lake Road, T23N R16E S25; Sattley, T20N R14E S9; Hwy 70 (The Buttes), T23N R15E S28; Sugarloaf, T23N R15E S17 [= *Zigadenus p.*].

Toxicoscordion venenosum S. Wats. var. ***venenosum*** DEATH CAMAS
Common, moist grassy areas and seeps. May-Jul. Yuba Pass, T20N R13E S11; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17 [= *Zigadenus v.* var. *v*].

VERATRUM Corn Lily, False Hellebore

Veratrum californicum Durand var. ***californicum*** CORN LILLY
Common, wet meadows and seeps. Jul-Aug. Sattley, T20N R14E S9.

ORCHIDACEAE Orchid Family

CORALLORHIZA Coral Root

Corallorhiza maculata (Raf.) Raf. var. ***maculata*** SPOTTED CORAL ROOT
Common, in deep duff of fir forests. Jun-Aug. Sattley, T20N R14E S9; Sierraville, T20N R14E S13.

GOODYERA

Goodyera oblongifolia Raf. RATTLESNAKE PLANTAIN
Common, drying woodland floors. May-Sep. Sattley (Chapman Saddle Road), T21N R14E S30; Calpine, T21N R14E S17.

LISTERA Twayblade

Listera convallarioides (Sw.) Elliott BROAD LEAVED TWAYBLADE
Fairly common, moist areas in alder and willow thickets. May-Aug. To be looked for in the Yuba Pass area.

PLATANTHERA Bog Orchid

Platanthera dilatata (Pursh) L.C. Beck var. ***leucostachys*** (Lindl.) Luer SIERRA BOG ORCHID
Common, springs and very wet meadows. May-Aug. Yuba Pass, T20N R13E S11; Sattley, T20N R14E S9.

Platanthera sparsiflora (S. Wats.) Schltr. SPARSE FLOWERED BOG ORCHID
Fairly common, wet boggy meadows. May-Sep. Yuba Pass, T20N R13E S11.

SPIRANTHES Ladies Tresses

Spiranthes romanzoffiana Cham. HOODED LADIES TRESSES
Uncommon, wet boggy meadows. May-Sep. Yuba Pass, T20N R13E S11.

POACEAE Grass Family

AEGILOPS Goatgrass

Aegilops cylindrica Host JOINTED GOATGRASS
Disturbed sites and fields. May-Jul. Reported from Beckwourth, T23N R14E S26.

AGROPYRON Wheatgrass

Agropyron cristatum (L.) Gaertn. subsp. *pectinatum* (M. Bieb.) Tzvelev DESERT WHEAT GRASS, CRESTED WHEAT GRASS
Degraded agricultural lands. Used as a pasture mix in the past. Jun-Aug. 6 Mile Road (Co. Road A-24, 4 mi N of Loyalton), T22N R15E S25; Sugarloaf, T23N R15E S17.

AGROSTIS Bentgrass

Agrostis capillaris L. COLONIAL BENTGRASS
Infrequent, moist disturbed areas. Jul-Sep. Beckwourth Sattley Road (S of Hwy 70), T23N R14E S35.

Agrostis exarata Trin. SPIKE BENTGRASS
Moist meadows and stream banks. Jun-Aug. Beckwourth Sattley Road (N of Sattley), T21N R14E S21.

Agrostis gigantea Roth GIANT BENTGRASS
Disturbed areas. Sometimes used for reseeding meadows. Jun-Sep. Marble Lane, T22N R15E S18; Sattley, T20N R14E S33.

Agrostis humilis Vasey MOUNTAIN BENT GRASS
Moist to dry subalpine meadows. Jul-Aug. This taxon has been collected just W of Yuba Pass.

Agrostis idahoensis Nash IDAHO BENTGRASS
Fairly common. Meadows, along streams and areas of late snow melt. Jul-Aug. To be looked for as this taxon is found just outside the project area on Sulphur Creek.

Agrostis oregonensis Vasey OREGON REDTOP
Moist meadows and stream banks. Jun-Jul. To be looked for as this taxon has been collected to the south of the project area in the Webber Lake area.

Agrostis pallens Trin. LEAFY BENTGRASS
Fairly common, drying meadows and woods. Apr-Aug. Ramelli Ranch, T23N R14E S27; Vinton, T23N R16E S34.

Agrostis variabilis Rydb. VARIABLE BENTGRASS
Rocky slopes and meadows. Jul-Aug. Coburn Lake, T20N R14E S29.

ALOPECURUS Foxtail

Alopecurus arundinaceus L. CREEPING MEADOW FOXTAIL
The specimens cited seem to represent the first collections of this species in California (RENO29861 & CAS824085, W. & N. Harnach 56, 5 May 1989, Loyalton). Loyalton, T21N R15E S13.

Alopecurus aequalis Sobol. var. ***aequalis*** SHORT AWNED FOXTAIL
Fairly common, wet meadows and stream banks. May-Jul. Hwy 49 (S of Sattley), T20N R14E S9; Antelope Valley, T21N R15E S21; Sugarloaf, T23N R15E S17.

Alopecurus carolinianus Walt. CAROLINA FOXTAIL
Locally frequent, wet meadows and disturbed river banks. Jun-Aug. Ramelli Ranch, T23N R14E S26; Marble Lane, T22N R15E S18.

Alopecurus geniculatus L. GENICULATE FOXTAIL
Wet river banks. Jun-Aug. Ramelli Ranch, T23N R14E S28.

Alopecurus pratensis L. MEADOW FOXTAIL
Locally common, meadows and pond edges. May-Jul. Heriot Lane, T22N R14E S28; Antelope Valley, T21N R15E S21.

Alopecurus saccatus Vasey PACIFIC FOXTAIL
Uncommon, drying vernal areas. Mar-May. Antelope Valley, T21N R15E S21; Calpine, T21N R14E S15.

APERA

Apera interrupta (L.) Beauv. DENSE SILKY BENT
Uncommon, disturbed areas. Jun-Jul. Dyson Lane (S of Hwy 70), T22N R15E S6.

ARRHENATHERUM Oat Grass

Arrhenatherum elatius (L.) J. Presl & C. Presl. TALL OAT GRASS
Uncommon. Usually found in disturbed areas. May-Jul. Sugarloaf, T23N R15E S17; Doe Canyon (SE of Loyalton), T21N R16E S29.

AVENA Oat

Avena sativa L. OATS
Uncommon. Roadsides and old fields. Apr-Jun. Dyson Lane, T22N R16E S13.

BECKMANNIA Slough Grass

Beckmannia syzigachne (Steud.) Beauv. AMERICAN SLOUGH GRASS
Wet roadside ditches and sluggish waters. May-Jul. Marble Lane, T22N R14E S13; Beckwourth Sattley Road, T21N R14E S21; Ramelli Ranch, T23N R14E S27.

BROMUS Brome

Bromus carinatus Hook.& Arn. var. ***carinatus*** CALIFORNIA BROME
Dry open slopes. Apr-Aug. Sugarloaf, T23N R15E S19; Newman Point, T21N R14E S25; Yuba Pass, T20N R13E S11.

Bromus carinatus Hook.& Arn. var. ***marginatus*** (Steud.) Barkworth & Anderton MOUNTAIN BROME
Dry open slopes. Apr-Aug. Loyalton, T21N R15E S13; Newman Point, T21N R14E S26; Beckwourth, T23N R14E S26.

Bromus commutatus Schrad. HAIRY CHESS, MEADOW BROME
Disturbed areas. May-Jul. Sattley, T20N R14E S15; Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S27.

Bromus grandis (Shear) Hitchc. TALL BROME
Dry open areas. May-Jul. Reported from just W of Yuba Pass.

Bromus hordeaceus L. SOFT BROME
Uncommon. Disturbed areas. Apr-Jul. Heriot Lane (N of Hwy 49), T22N R15E S33; Sugarloaf, T23N R15E S17; Beckwourth, T23N R14E S26.

Bromus inermis Leyss. SMOOTH BROME
Fairly common, disturbed areas. May-Aug. Ramelli Ranch, T23N R14E S27; Dyson Lane, T22N R15E S13; Sugarloaf, T23N R15E S17.

Bromus japonicus Thunb. JAPANESE CHESS
Common, open ground and disturbed areas. May-Jul. Marble Lane, T22N R15E S18; Antelope Valley, T21N R15E S21.

Bromus laevipes Shear CHINOOK BROME
Uncommon, conifer forest and scrublands. May-Jul. Two records that just list "Sierra Valley", Plumas County.

Bromus orcuttianus Vasey ORCUTT'S BROME
Dry meadows, scrub and open forests. Jun-Jul. One record for Yuba Pass area (UCD59260, A.A. Beetle, #3041, Near summit of Yuba Pass, 6350 ft.) and one record for "mountains N of Sierra Valley".

Bromus porteri (J.M. Coult.) Nash NODDING BROME
Uncommon, shaded stream banks. Jun-Aug. Sattley, T20N R14E S9 [*B. anomalus*].

Bromus racemosus L. SMOOTH BROME
Uncommon, disturbed areas. Jun-Aug. Ramelli Ranch, T23N R14E S26.

Bromus secalinus L. RYE BROME
Uncommon, disturbed areas. May-Jul. Two collections for Sierra Valley; Loyalton (CAS977420) and Vinton (SEINET187873).

Bromus tectorum L. CHEAT GRASS
Common, disturbed areas and burns. May-Aug. Calpine, T21N R14E S16; Newman Point, T21N R14E S25; Antelope Valley, T21N R15E S21.

Bromus vulgaris (Hook.) Shear COLUMBIA BROME
Open rocky woodlands. May-Aug. Chapman Saddle Road (southwest of Calpine), T21N R13E S26.

CALAMAGROSTIS Reed Grass

Calamagrostis stricta (Timm) Koeler subsp. ***inexpansa*** (A. Gray) C.W. Greene NARROW SPIKED REED GRASS
Uncommon, wet meadows and marshlands. Jun-Aug. Marble Lane, T22N R15E S18.

CINNA Woodreed

Cinna latifolia (Gopp.) Griseb. DROOPING WOODREED
Wet meadows and stream banks. Jul-Aug. To be looked for in the Yuba Pass areas as this taxon has been collected just to the west.

CRYPSIS Prickle Grass

Crypsis alopecuroides (Piller & Mitterp.) Schrad. FOXTAIL SWAMP GRASS
Fairly common, roadside ditches and river margins. Jun-Oct. Ramelli Ranch, T23N R14E S26; Beckwourth Sattley Road (S of Hwy 70), T23N R41E S35.

Crypsis schoenoides (L.) Lam. SWAMP GRASS
Fairly common, roadside ditches and river banks. Jun-Oct. Ramelli Ranch, T23N R14E S27.

DACTYLIS Orchard Grass

Dactylis glomerata L. ORCHARD GRASS
Occasional, edges of old fields and seeded pastures. May-Aug. Loyalton, T21N R15E S13.

DANTHONIA Oatgrass

Danthonia californica Bol. CALIFORNIA OATGRASS
Uncommon, moist slopes and drying meadow edges. May-Jul. Knuthson Meadows, T21N R14E S5.

Danthonia unispicata (Thurb.) Vasey ONE FLOWERED OATGRASS
Common, drying flats. May-Jul. Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

DESCHAMPSIA Hair Grass

Deschampsia cespitosa (L.) P. Beauv. var. ***cespitosa*** TUFTED HAIR GRASS
Common, wet meadows and river banks. Jul-Aug. Beckwourth Sattley Road (N of Sattley), T21N R14E S33; Ramelli Ranch, T23N R14E S26.

Deschampsia danthonioides (Trin.) Munro ANNUAL HAIR GRASS
Common, moist swales and pools. Apr-Aug. Sattley, T20N R14E S4; Ramelli Ranch, T23N R14E S27; Sugarloaf, T23N R15E S17.

Deschampsia elongata (Hook.) Munro SLENDER HAIR GRASS
Wet meadows and streams. May-Sep. This taxon has been reported just W of Yuba Pass.

DISTICHLIS Salt Grass

Distichlis spicata (L.) Greene DESERT SALT GRASS
Common, subalkaline areas. Apr-Sep. Beckwourth Sattley Road (N of Sattley), T21N R14E S28; Dyson Lane (S of Hwy 70), T22N R15E S6; Marble Lane, T22N R14E S13.

ECHINOCHLOA Barnyard Grass

Echinochloa muricata (P. Beauv.) Fernald var. ***microstachya*** Wieg. BARNYARD GRASS
Uncommon, wet ditches and river edges. Jun-Oct. Ramelli Ranch, T23N R14E S27.

ELYMUS Wild Rye

Elymus caput-medusae L. MEDUSA HEAD
Common, disturbed areas. Apr-Jul. Ramelli Ranch, T23N R14E S27; Frenchman lake Road, T23N R16E S10; Sugarloaf, T23N R15E S17 [= *Taeniatherum c.*].

Elymus cinereus Scribn. & Merr. BASIN WILD RYE
Sagebrush slopes and flats. Jun-Aug. Hwy 49 (S of Vinton), T22N R16E S8; Beckwourth Sattley Road, T22N R14E S34; Sugarloaf, T23N R15E S17 [= *Leymus c.*].

Elymus condensatus J. Presl GIANT WILD RYE
Scattered, sagebrush scrub. Jun-Aug. Sugarloaf, T23N R15E S20 [= *Leymus c.*].

Elymus elymoides (Raf.) Swezey var. ***brevifolius*** (J.G. Sm.) Dorn SHORT LEAVED SQUIRRELTAIL
Scattered, open sagebrush scrub. Jul-Aug. Beckwourth, T23N R14E S26; Loyalton, T21N R15E S17.

Elymus elymoides (Raf.) Swezey var. ***californicus*** (J.G. Sm.) J.P. Sm. CALIFORNIA SQUIRRELTAIL
Open dry areas. Jul-Aug. Reported just W of Yuba Pass and collected to the N in Red Clover Valley.

Elymus elymoides (Raf.) Swezey var. ***elymoides*** SQUIRRELTAIL
Common, drying flats and slopes. Jun-Aug. Beckwourth Sattley Road (S of Hwy 70), T22N R14E S12; Calpine, T21N R14E S16 [= *Sitanion hystrix*].

Elymus glaucus Buckley subsp. ***glacus*** BLUE WILD RYE
Fairly common, openings in sagebrush and woods. Jun-Aug. Sierraville, T20N R14E S13; Beckwourth Sattley Road (N of Sattley), T21N R14E S33; Frenchman Lake Road, T23N R16E S10; Sugarloaf, T23N R15E S17.

Elymus hispidus (Opiz) Melderis INTERMEDIATE WHEATGRASS
Scattered, roadsides. Jun-Aug. Vinton, T23N R16E S34; Ramelli Ranch, T23N R14E S27.

Elymus lanceolatus (Scribn. & J.G. Sm.) Gould subsp. ***lanceolatus*** THICKSPIKE WHEATGRASS
Uncommon, valley floors and open woodlands. Jun-Sep. Dyson Lane, T22N R16E S13.

Elymus multisetus (J.G. Sm.) Burtt Davy BIG SQUIRRELTAIL
Scattered, open flats. May-Jul. Beckwourth, T23N R14E S26.

Elymus ponticus (Podp.) N. Snow TALL WHEATGRASS
Disturbed roadsides. Jun-Jul. Chilcoot, T23N R16E S36; Loyalton (4 mi N of on Co. Rd A-24), T22N R15E S25; Dyson Lane, T22N R15E S13; Sugarloaf, T23N R15E S17 [= *Elytrigia elongata*].

Elymus repens (L.) Gould QUACK GRASS
Disturbed areas and fields. Apr-Aug. Loyalton, T22N R15E S18; Calpine, T21N R14E S28.

Elymus smithii (Rydb.) Gould WESTERN WHEAT GRASS
Uncommon, dry subalkaline soil. Vinton (S on Hwy. 49), T22N R16E S8.

Elymus trachycaulus (Link) Shinners subsp. ***trachycaulus*** SLENDER WHEATGRASS
Uncommon, roadsides and old fields. Jun-Aug. Dyson Lane, T22N R16E S13 [= *Agropyron t*].

Elymus triticoides Buckley BEARDLESS WILD RYE
Common, saline meadows. Jun-Jul. Vinton, T23N R16E S34; Marble Lane, T22N R14E S13; The Buttes, T23N R15E S28; Loyalton, T22N R15E S13.

ERAGROSTIS Lovegrass

Eragrostis cilianensis (All.) Janch. STINK GRASS
Disturbed roadside ditch, uncommon. Jun-Oct. Marble Lane, T22N R15E S17.

Eragrostis mexicana (Hornem.) Link subsp. ***virescens*** (J. Presl) S.D. Koch & Sánchez Vega MEXICAN LOVEGRASS
Wet roadside ditches and stream banks. May-Oct. Frenchman Lake Road, T23N R16E S11.

Eragrostis pectinacea (Michx.) Nees var. ***pectinacea*** CAROLINA LOVE GRASS
Disturbed roadside ditch, uncommon. Jul-Nov. Marble Lane, T22N R15E S17.

FESTUCA Fescue

Festuca arundinacea Schreb. TALL FESCUE
Disturbed areas and fields. Used in pasture mixes. May-Jun. Sugarloaf, T23N R15E S17.

Festuca bromoides L. BROME FESCUE
Sagebrush scrub. Apr-Jun. One record for Sierra Valley (UCD93556, J.G. Lemmon, s.n., May 20 1889) [= *Vulpia b*].

Festuca idahoensis Elmer IDAHO FESCUE
Common, open woodlands and sagebrush. Jul-Sep. Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16; Beckwourth Sattley Road, T21N R14E S9.

Festuca microstachys Nutt. SMALL FESCUE
Fairly frequent, generally sandy areas. Apr-Jun. Frenchman Lake Road, T23N R16E S24; The Buttes, T23N R15E S28 [= *Vulpia m*].

Festuca occidentalis Hook. WESTERN FESCUE
Open conifer forest. Apr-Jul. Two records for Sierra Valley with unknown collectors (UCD66165 & UCD66171).

Festuca pratensis Huds. MEADOW FESCUE
Disturbed areas and meadows. May-Jul. Chilcoot, T23N R16E S11 [= *Schedonorus p*].

Festuca rubra L. RED FESCUE
Sand dunes and grasslands. May-Jul. One record for Sierra Valley (UCD66363, unknown collector, #4652, Sierra Valley, Plumas Co.).

Festuca subulata Trin. BEARDED FESCUE
Moist meadows and open forest. Jun-Aug. To be looked for in the Yuba Pass area (UCD66432, A.A. Beetle 3044, Aug. 17, 1944, near summit of Yuba Pass, 6350 ft.).

Festuca viridula Vasey GREEN FESCUE
Subalpine meadows and open forest. Jun-Aug. To be looked for in the Yuba Pass area.

GLYCERIA Manna Grass

Glyceria borealis (Nash) Batch. NORTHERN MANNA GRASS
Common, wet places and stream margins. Jun-Aug. Marble Lane, T22N R15E S18; Loyalton, T21N R15E S13.

Glyceria elata (Rydb.) M.E. Jones FOWL MANNA GRASS
Fairly common, meadows and spring areas. Jul-Aug. Calpine, T21N R14E S19; Sattley, T20N R14E S9.

Glyceria striata (Lam.) Hitchc. MANNA GRASS
Fairly common, meadows and spring areas. Jul-Aug. Sattley, T20N R14E S9.

HOLCUS Velvet Grass

Holcus lanatus L. COMMON VELVET GRASS
Uncommon, wet meadows. Jun-Aug. Sattley, T20N R14E S9.

HORDEUM Barley

Hordeum brachyantherum Nevski subsp. ***brachyantherum*** MEADOW BARLEY
Common, moist areas. May-Aug. Ramelli Ranch, T23N R14E S27; Marble Lane, T22N R14E S13; Knuthson Meadows, T21N R14E S5; Sugarloaf, T23N R15E S17.

Hordeum jubatum L. subsp. ***jubatum*** FOXTAIL BARLEY
Common, moist disturbed areas. May-Jul. Sugarloaf, T23N R15E S17; Dyson Lane (W of Hwy 49), T22N R16E S18; Calpine, T21N R14E S22.

Hordeum marinum Huds. subsp. *gussoneanum* (Parl.) Thell. MEDITERRANEAN BARLEY
Fairly common, wet subalkaline areas. Apr-Jun. Vinton, T23N R16E S34; Marble Lane, T22N R14E S13 [= *H. geniculatum*].

Hordeum murinum L. MOUSE BARLEY
Fairly common, old fields and waste places. Apr-Jul. Sugarloaf, T23N R15E S17.

KOELERIA Jun Grass

Koeleria macrantha (Ledeb.) Schult. JUN GRASS
Fairly common, dry open areas. May-Jul. Ramelli Ranch, T23N R14E S27; Frenchman Lake Road, T23N R16E S30.

MELICA Onion Grass

Melica bulbosa Porter & J.M. Coult. WESTERN ONION GRASS
Meadows and moist to drying slopes. Jul-Aug. Antelope Valley, T21N R15E S28; Sugarloaf, T23N R15E S17.

Melica fugax Bol. SMALL ONION GRASS
Dry open wooded slopes. May-Jul. Calpine, T21N R14E S16; Vinton, T23N R16E S35; Sugarloaf, T23N R15E S17.

Melica stricta Bol. NODDING ONION GRASS
Widely scattered, rocky areas. Jun-Aug. Sugarloaf, T23N R15E S17.

Melica subulata (Griseb.) Scribn. ALASKAN ONION GRASS
Shaded woods. Apr-Jul. This taxon has been reported from just W of Yuba Pass.

MUHLENBERGIA Muhly Grass

Muhlenbergia andina (Nutt.) Hitchc. FOXTAIL MUHLY
Wet meadows and stream banks. Jul-Sep. Yuba Pass, T20N R13E S11.

Muhlenbergia asperifolia (Trin.) Parodi SCRATCHGRASS
Uncommon, hot wells, subalkaline areas and wet muddy areas. Jul-Oct. Marble Lane, T22N R14E S13; Hwy 49 (S of Vinton), T22N R16E S4.

Muhlenbergia filiformis (S. Wats.) Rydb. SLENDER MUHLY
Common, seeps, springs and vernal areas. May-Aug. Calpine, T21N R16E S16; Beckwourth Sattley Road (N of Sattley), T21N R14E S22; Yuba Pass, T20N R13E S14.

Muhlenbergia richardsonis (Trin.) Rydb. MATTED MUHLY
Common, moist to dry meadows. Jun-Aug. Sugarloaf, T23N R15E S17; Marble Lane, T22N R14E S13; Calpine, T21N R14E S16; Ramelli Ranch, T23N R14E S26; Loyalton, T21N R15E S13; Mapes Canyon, T23N R14E S3.

PANICUM Panicgrass

Panicum capillare L. OLD WITCH GRASS
Uncommon, wet waste places. Mar-Nov. Dyson Lane, T22N R15E S14; Loyalton, T21N R15E S13; Ramelli Ranch, T23N R14E S26.

PHLEUM Timothy

Phleum alpinum L. MOUNTAIN TIMOTHY
Wet meadows and stream banks. Jul-Aug. Yuba Pass, T20N R13E S11.

Phleum pratense L. COMMON TIMOTHY
Scattered, meadows. May-Jun. Sierraville, T20N R14E S14; Loyalton, T21N R15E S12.

POA Bluegrass

Poa bolanderi Vasey BOLANDER'S BLUE GRASS
Mountains and open pine forests. Jun-Aug. Yuba Pass, T20N R13E S11.

Poa bulbosa L. BULBOUS BLUE GRASS
Common, found throughout the valley.

Poa compressa L. CANADIAN BLUE GRASS
Common, dry meadows. Apr-Aug. Ramelli Ranch, T23N R14E S27; Knuthson Meadows, T21N R14E S5; Sierraville, T20N R14E S14.

Poa cusickii Vasey subsp. ***cusickii*** CUSICK'S BLUE GRASS
Uncommon, dry meadows, sagebrush scrub and rocky slopes. May-Jul. Vinton, T23N R16E S33.

Poa cusickii Vasey subsp. ***epilis*** (Scribn.) W.A. Weber CUSICK'S BLUE GRASS
Uncommon, dry meadows, sagebrush scrub and rocky slopes. Jun-Aug. Vinton, T23N R16E S33.

Poa fendleriana (Steud.) Vasey subsp. ***longiligula*** (Scribn. & T.A. Williams) Soreng MUTTONGRASS
Common, rocky slopes. Apr-Jul. Sugarloaf, T23N R15E S17; Newman Point, T21N R14E S25; Frenchman Lake Road, T23N R16E S25.

Poa glauca Vahl subsp. ***rupicola*** (Rydb.) W.A. Weber TIMBERLINE BLUE GRASS
Uncommon, rocky slopes. Normally found at much higher elevations. Jul-Sep. Antelope Valley, T21N R15E S28.

Poa palustris L. FOWL BLUE GRASS
Common, moist or drying meadows and stream banks. May-Sep. Beckwourth Sattley Road (N of Sattley), T21N R14E S22.

Poa pratensis L. subsp. *pratensis* KENTUCKY BLUE GRASS
Frequent, open woods, stream banks and meadows. Apr-Jul. Sierraville, T20N R14E S24; Sugarloaf, T23N R15E S17; Hwy 49 (W of Sattley), T21N R14E S31.

Poa secunda J. Presl subsp. ***juncifolia*** (Scribn.) Soreng RUSH BLUE GRASS
Moist subalkaline and sagebrush flats. Apr-Jul. Marble Lane, T22N R15E S18; Sugarloaf, T23N R25E S17.

Poa secunda J. Presl subsp. ***secunda*** SANDBERG'S BLUE GRASS
Common, dry meadows and sagebrush flats. Apr-Aug. Sugarloaf, T23N R15E S17; Ramelli Ranch, T23N T14E S27; Newman Point, T21N R14E S25; Sattley, T21N R14E S33.

Poa trivialis L. ROUGH BLUE GRASS
Common, drying meadows. Apr-Aug. Yuba Pass, T20N R13E S11.

Poa wheeleri Vasey WHEELER'S BLUE GRASS
Uncommon, open woodlands. May-Aug. Sugarloaf, T23N R15E S17; Hwy 49 (W of Sattley), T21N R14E S31.

POLYPOGON Beard Grass

Polypogon maritimus Willd. MEDITERRANEAN BEARD GRASS
Wet meadows and roadside ditches. May-Jul. One record for Sierra Valley (CAS856181, Greg Sommers, #169, Jul 20, 1976). Marble Lane, T22N R14E S13.

Polypogon monspeliensis (L.) Desf. ANNUAL BEARD GRASS
Common, moist areas and roadside ditches. Apr-Aug. Marble Lane, T22N R14E S13; Ramelli Ranch, T23N R13E S27.

PUCCINELLIA Alkali Grass

Puccinellia distans (Jacq.) Parl. EUROPEAN ALKALI GRASS
Saline meadows and alkali areas. Jun-Jul. Vinton, T23N R16E S34; The Buttes, T23N R15E S35; Sattley, T21N R14E S28; Marble Lane, T22N R15E S18.

Puccinellia lemmonii (Vasey) Scribn. LEMMON'S ALKALI GRASS
Common, subalkaline areas. May-Aug. Marble Lane, T22N R14E S13; Co. Rd. A-24 (N of Loyalton), T22N R15E S36; Hwy 70, T23N R15E S35.

Puccinellia nuttalliana (Schult.) Hitchc. NUTTALL'S ALKALI GRASS
Uncommon, wet grassy areas. Jun-Sep. Marble Lane, T22N R14E S13.

SECALE Rye

Secale cereale L. RYE
Common, roadsides and old fields. May-Jul. Hwy 49 (S of Vinton), T22N R16E S8; Sugarloaf, T23N R15E S17; Calpine, T21N R14E S16.

SETARIA Bristle Grass

Setaria viridis (L.) P. Beauv. GREEN BRISTLE GRASS
Uncommon, moist meadows. May-Oct. Calpine, T21N R14E S17.

SPOROBOLUS Dropseed

Sporobolus cryptandrus (Torr.) A. Gray SAND DROPSEED
Uncommon, roadside ditches. Apr-Aug. Dyson Lane, T22N R15E S13; Beckwourth Pass, T22N R17E S6.

STIPA Needle Grass

Stipa comata Trin. & Rupr. var. ***comata*** NEEDLE AND THREAD
Common, dry sagebrush lands. May-Jul. Vinton, T23N R16E S22; Hwy 49 (S of Vinton), T22N R16E S9; Sugarloaf, T23N R15E S17; Beckwourth, T23N R14E S26 [= *Achnatherum c.* var. *c.*].

Stipa hymenoides Roem. & Schult. INDIAN RICEGRASS
Scattered, limited to N and E side of the valley, dry sandy places. Jun-Jul. Dyson Lane, T22N R15E S16; Beckwourth Pass, T22N R17E S6; Vinton, T23N R16E S22; Sugarloaf, T23N R15E S17 [= *Achnatherum h.*].

Stipa lemmonii (Vasey) Barkworth var. ***lemmonii*** LEMMON'S NEEDLE GRASS
Fairly frequent, rocky and open sandy slopes. May-Jul. Sierraville, T20N R14E S24; Newman Point, T21N R14E S25; Sattley, T21N R14E S33 [= *Achnatherum l.* subsp. *l.*].

Stipa lepida Hitchc. FOOTHILL NEEDLE GRASS
Uncommon, dry slopes and grasslands. Apr-Jun. Ramelli Ranch, T23N R14E S27 [= *Nassella l.*].

Stipa lettermanii Vasey LETTERMAN'S NEEDLE GRASS
Limited, openings in woods. May-Aug. Ross Meadows, T23N R14E S34; Antelope Valley, T21N R15E S28 [= *Achnatherum l.*].

Stipa nelsonii Scribn. var. ***dorei*** (Barkworth & J.R. Maze) Dorn MOUNTAIN NEEDLE GRASS
Fairly common, openings in brush and dry meadows. Jun-Sep. Beckwourth, T23N R14E S26 [= *Achnatherum n.* subsp. *d.*].

Stipa occidentalis S. Wats. var. ***californica***(Merr. & Burtt Davy) C.L. Hitchc. CALIFORNIA GRASS
Frequent, open slopes and woods. May-Aug. Dyson Lane, T22N R15E S6; Sattley, T20N R14E S9 [= *Achnatherum o.* subsp. *c.*].

Stipa occidentalis S. Wats. var. ***occidentalis*** WESTERN NEEDLE GRASS
Fairly common, open dry sites. Jun-Aug. Hwy 49 (W of Sattley), T21N R14E S31 [= *Achnatherum o.* subsp. *o.*].

Stipa occidentalis S. Wats. var. ***pubescens*** (Vasey) J.R. Maze et. al. PUBESCENT WESTERN NEEDLE GRASS
Fairly common, open slopes and flats. May-Aug. Dyson Lane, T22N R16E S33; Hwy 49 (W of Sattley), T21N R14E S31; Beckwourth, T23N R14E S26 [= *Achnatherum o.* subsp. *p.*].

Stipa thurberiana Piper THURBER'S NEEDLE GRASS, NEEDLE & THREAD
Sagebrush scrub. May-Jul. Vinton, T23N R16E S28; Antelope Valley, T21N R15E S28 [= *Achnatherum t.*].

Stipa webberi (Thurb.) B.L. Johnson WEBBER'S NEEDLE GRASS
Volcanic outcrops on ridges and dry openings in sagebrush. May-Jul. No confirmed collections for the Sierra Valley region but this taxon has been collected just outside the project area [= *Achnatherum w.*].

TORREYOCHLOA

Torreyochloa pallida (Torr.) G.L. Church var. ***pauciflora*** (J. Presl) J.I Davis WEAK MANNA GRASS
Uncommon, wet banks and shallow water. Jul-Sep. Coburn Lake, T20N R14E S29.

TRISETUM False Oat

Trisetum canescens Buckley NODDING OAT GRASS
Common, wet meadows. May-Aug. Yuba Pass, T20N R13E S14.

Tristemum projectum Louis-Marie Per. INTERRUPTED FALSE OAT
Meadows, stream banks and dry open forest. Jul-Sep. Yuba Pass, T20N R13E S14.

Tristemum spicatum (L.) K. Richt. SPIKE FALSE OAT
Moist meadows and conifer forest. Jul-Aug. Reported from just W of Yuba Pass.

POTAMOGETONACEAE Pondweed

POTAMOGETON Pondweed

Potamogeton epihydrus Raf. NUTTALL'S RIBBON-LEAVED PONDWEED
Limited, shallow water. CRPR 2B. Jul-Aug. Snow Lake (N of Chilcoot), T23N R17E S6.

Potamogeton foliosus Raf. subsp. ***foliosus*** LEAFY PONDWEED
Uncommon, ponds and roadside ditches. Jul-Oct. Sierraville, T20N R14E S11; Sattley, T21N R14E S33.

Potamogeton gramineus L. GRASS LEAVED PONDWEED
Uncommon, ponds and marshes. Jul-Aug. Calpine, T21N R14E S16; Marble Lane, T22N R14E S13.

Potamogeton natans L. FLOATING LEAVED PONDWEED
Fairly common, ponds and roadside ditches. Jun-Aug. Sattley, T21N R14E S33; Hwy 49 (between Sattley and Sierraville), T20N R14E S11; Beckwourth, T23N R14E S26.

Potamogeton nodosus Poir. LONG LEAVED PONDWEED
Shallow water and ponds. Jun-Jul. Marble Lane, T22N R15E S18; Hwy 49 (W of Sierraville), T20N R14E S12.

Potamogeton pusillus L. SMALL PONDWEED
Sluggish water and shallow ponds. May-Jun. Marble Lane, T22N R14E S13.

STUCKENIA Pondweed

Stuckenia filiformis (Pers.) Borner subsp. ***alpina*** (Blytt) R.R. Haynes et. al. NARROW LEAVED PONDWEED
Uncommon, slow moving water and shallows. May-Jul. Ramelli Ranch, T23N R14E S26.

RUSCACEAE Butcher's Broom

MAIANTHEMUM False Solomon Seal

Maianthemum racemosum (L.) Link WESTERN SOLOMON SEAL
Fairly common, shaded woods. Mar-Jul. Sattley, T21N R14E S30; Yuba Pass, T20N R13E S11 [= *Smilacina r.*].

THEMIDACEAE Brodiaea Family

BRODIAEA

Brodiaea elegans Hoover subsp. ***elegans*** ELEGANT BRODIAEA
Local, heavy soils of open or wooded slopes and flats. May-Jul. Sattley, T21N R14E S33.

Brodiaea minor (Benth.) S. Wats. DWARF BRODIAEA
Uncommon, clay soils. Apr-Jul. Beckwourth Sattley Road, T21N R14E S9.

DICHELOSTEMMA Wild Hyacinth

Dichelostemma multiflorium (Benth.) A. Heller WILD HYACINTH
Uncommon, rocky volcanic slopes. May-Jun. Calpine, T21N R14E S18.

MUILLA

Muilla transmontana Greene TRANSMONTANE MUILLA
Local, openings in the sagebrush. May-Jun. Beckwourth Pass, T22N R17E S6; Hwy 70, T23N R15E S35; Frenchman Lake Road, T23N R16E S24.

TRITELEIA

Triteleia bridgesii (S. Wats.) Greene BRIDGE'S TRITELEIA
Normally below 4000 feet, woods and open slopes. Apr-Jun. One collection for Sierra Valley (UC333357, Lemmon, Jul 1883).

Triteleia hyacinthina (Lindl.) Greene WILD HYACINTH
Common, vernally moist slopes, meadows and stream banks. Apr-Jul. Calpine, T21N R14E S17; Sugarloaf, T23N R15E S17.

Triteleia ixioides (W.T. Aiton) Greene subsp. ***anilina*** (Greene) L.W. Lenz MOUNTAIN PRETTY FACE
Common, shady to open sandy and rocky areas. May-Jul. Yuba Pass, T20N R13E S11.

Triteleia laxa Benth. ITHURIEL'S SPEAR
Open forest and woodlands on clay soils. Apr-Jun. One record for Sierra Valley (UC367045, J.G. Lemmon & Wife, Jun 1883, Sierra and Indian Valley).

TOFIELDIACEAE

TRIANTHA

Triantha occidentalis (S. Wats.) R.R. Gates subsp. ***occidentalis*** WESTERN TOFIELDIA
Locally frequent, very wet meadows and fens. Jul-Aug. Yuba Pass, T20N R13E S11 [= *Tofieldia o.* subsp. *o.*].

THYPHACEAE Cattail Family

SPARGANIUM Bur-Reed

Sparganium angustifolium Michx. NARROW-LEAVED BUR-REED
Slow moving waters. Jun-Aug. Ramelli Ranch, T23N R14E S26.

Sparganium emersum Rehmann EMERSED BUR REED
Fairly common. Ponds, marshes and slow moving water. Summer. Marble Lane, T22N R15E S18; Ramelli Ranch, T23N R14E S27; Hwy 49, T20N R14E S11.

Sparganium eurycarpum A. Gray var. ***eurycarpum*** TRUNCATE FRUITED BUR REED
Uncommon, marshlands. Jun-Aug. Marble Lane, T22N R15E S18.

TYPHA Cattail

Typha latifolia L. BROAD LEAVED CATTAIL
Common, wet roadside ditches. May-Jul. Sierraville, T20N R14E S13; Calpine, T21N R14E S17; Marble Lane, T22N R14E S13; Sugarloaf, T23N R15E S17.

ZANNICHELLIACEAE Horned Pondweed Family

ZANNICHELLIA

Zannichellia palustris L. HORNED PONDWEED
Uncommon, slow streams and ponds. Apr-Oct. Dyson Lane, T22N T16E S18; Ramelli Ranch, T23N R14E S27.

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CYPERUS HASPAN (CYPERACEAE) NEW TO OKLAHOMA

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ABSTRACT

Cyperus haspan is reported in Pushmataha Co., Oklahoma, constituting the first report of the species in the state. A population of 25–30 individuals was discovered in a hillside bog, growing in association with numerous wetland species, 11 of which are currently being tracked as rare in Oklahoma. *Cyperus haspan* is known from the adjoining states of Texas, Arkansas, and Louisiana and occurs in the lower to middle Gulf Coastal Plain and the Atlantic Coastal Plain northward to Virginia.

Cyperus (Cyperaceae) is a pantemperate and tropical genus of about 600 species of nearly worldwide distribution (Tucker et al. 2002). Approximately 90 species of *Cyperus* occur in North America (Tucker 1986), with about 45 taxa known from Oklahoma (Hoagland et al. 2004). Despite moisture regime requirements of many species, several *Cyperus* species persist as pernicious weeds, especially non-native introductions (Hickman 1993; Li et al. 1999).

Although widely distributed as a genus, at least two-thirds of all known North American species occur in sandy soils (wet or dry). This biogeographical pattern remains consistent in regions of the Atlantic Coastal Plain, which contain the highest known *Cyperus* diversity within the USA (Tucker 1987; Li et al. 1999).

Based on the following specimen, we report *Cyperus haspan* L. (Figure 1) as new to the native flora of Oklahoma.

USA. **Oklahoma**. Pushmataha Co.: 0.9 mi N of the jct of Indian Nation Turnpike and Pushmataha/Choctaw County line, W side of Indian Nation Turnpike (34° 09' 45", 95° 35' 42"), 21 Nov 2015, *Singhurst* 21032 (BAYLU).

The *Cyperus haspan* population in Pushmataha County consisted of 25-30 individuals along a perennial spring run at the very head drainage of a hillside bog (Figure 2). Hillside bogs in southeastern Oklahoma are extremely rare (Hoagland 2000) and contain various plants tracked by the Oklahoma Natural Heritage Program as rare (Buthod 2013). In the following list of associated species, those 11 tracked as rare in Oklahoma are noted with an asterisk (*). Associated flora included *Acer rubrum*, *Agalinis* sp., *Andropogon virginicus* var. *virginicus*, *Boehmeria cylindrica*,

*Carex longii**, *C. oklahomensis**, *Cyperus strigosus*, *C. flavescens*, *Dichanthelium scoparium*, *Eleocharis tortilis**, *Eupatorium perfoliatum*, *E. rotundifolium* var. *rotundifolium*, *Fuirena squarrosa*, *Hydrolea ovata*, *Hypericum mutilum*, *Iris* sp., *Juncus effusus*, *J. validus*, *Leersia oryzoides*, *Ludwigia hirtella**, *Lycopodiella appressa**, *Mitreola sessilifolia**, *Nyssa sylvatica*, *Oldenlandia uniflora**, *Osmunda cinnamomea*, *O. regalis*, *Pluchea foetida**, *Polygonum hydropiperoides*, *Rhexia virginica*, *Rhynchospora corniculata*, *R. glomerata*, *R. gracilenta**, *Rubus* sp., *Salix nigra*, *Solidago rugosa*, *Sophronanthe (Gratiola) pilosa*, *Sphagnum* sp., *Triadenum walteri**, *Typha* sp., *Utricularia gibba*, *U. juncea**, *Vernonia* sp., *Viola* sp., and *Xyris jupicai*.

In the USA, *Cyperus haspan* occurs natively along the lower and middle Atlantic and Gulf Coastal plains from Virginia to central Texas (Tucker et al. 2002). The occurrence of the species in southeastern Oklahoma follows a pattern of Gulf Coastal Plain flora that is highly restricted to bogs ('isolated wetlands') in this state. Other rare plants of Oklahoma have the potential to occur at this bog site and consequently this site needs further investigation.

Figure 1. *Cyperus haspan* with associated flora in Pushmataha Co., Oklahoma. Photo by Jason R. Singhurst.

Figure 2. Hillside bog, Pushmataha Co. Oklahoma. Photo by Jason R. Singhurst.

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A RECENT COLLECTION OF *SOLIDAGO BUCKLEYI* (ASTERACEAE: ASTEREAE) IN ALABAMA AND A MULTIVARIATE MORPHOMETRIC COMPARISON OF *S. BUCKLEYI, S. PETIOLARIS* VAR. *PETIOLARIS,* AND *S. PORTERI*

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ABSTRACT

A collection of *Solidago buckleyi* was made in St. Clair Co., Alabama, in 2006: *Keener 4013* (UWAL, WAT). The WAT duplicate was included in a multivariate morphometric comparison of specimens of *S. buckleyi*, *S. petiolaris* var. *petiolaris*, and *S. porteri* and was placed a posteriori in *S. buckleyi* with 100% probability. This is the first confirmed collection of the species from Alabama since the original type material of the species was collected by S.B. Buckley in 1838. The collection represents a significant disjunction from the main area of distribution of the species in southern Missouri, adjacent Arkansas, and eastward though southern Illinois and adjacent Kentucky to extreme southwestern Indiana.

A goldenrod collection from Alabama was made and subsequently identified by Keener as *Solidago buckleyi* Torr. & A. Gray (St. Clair Co.: 2.0 air mi ENE of Ferguson Crossroad, Chandler Mountain, just W of Creel Chapel of Camp Sumatanga property, along NE facing bluff, 33.948293° N, 86.264177° W, 4 Nov 2007, *Keener 4013*; UWAL, WAT; Figs 1 and 2). The collection locality just under the bluff of the mountain is at the boundary of the Southwestern Appalachians and the Ridge and Valley Level III Ecoregions (Griffith et al 2001). It is also at a geologic boundary where Pottsville Formation sandstone along the rim of the mountain meets the Parkwood Formation shale just below the brow (Burchard & Andrews 1947). The soils weathered from Parkwood shale tends to be more alkaline than the soil from Pottsville sandstone above. As might be expected at a sharp geologic boundary, the assemblage of plants seemed to be a mixture of some odd associates including but not limited to *Rhus aromatica* and *Kalmia latifolia*. *Quercus montana* appeared to be one of the more dominant members of the canopy.

A duplicate of this collection was sent to Semple in 2016 for confirmation of identification following an email exchange regarding the specimen and possible alternative identifications, e.g. *S. porteri* Small if its lower stem and basal leaves are not present. The serrate mid stem leaves of *S. porteri* and *S. buckley* can be similar and both are very rare in Alabama. *Solidago buckleyi* is member of *Solidago* subsect. *Thyrsiflorae* A. Gray, which includes species that lack lower stem leaves at the time of flowering and phyllaries that are very sparsely to densely stipitate glandular and variously strigose. In comparison, *Solidago porteri* is a member of subsect. *Squarrosae* and has large petiolate basal stem leaves typical of the subsection and glabrous lower stems becoming sparsely to moderately strigose distally.

The original collection of S*olidago buckleyi* made in 1838 by S.B. Buckley came from "the interior" of Alabama based on a collection seen by Torrey and Gray. All other collections known for the species come from mainly Missouri, with some from northern Arkansas, southern Illinois, south-

Figure 1. *Solidago buckleyi* from St. Clair Co., Alabama: *B.R. Keener 4013* (WAT, unmounted).

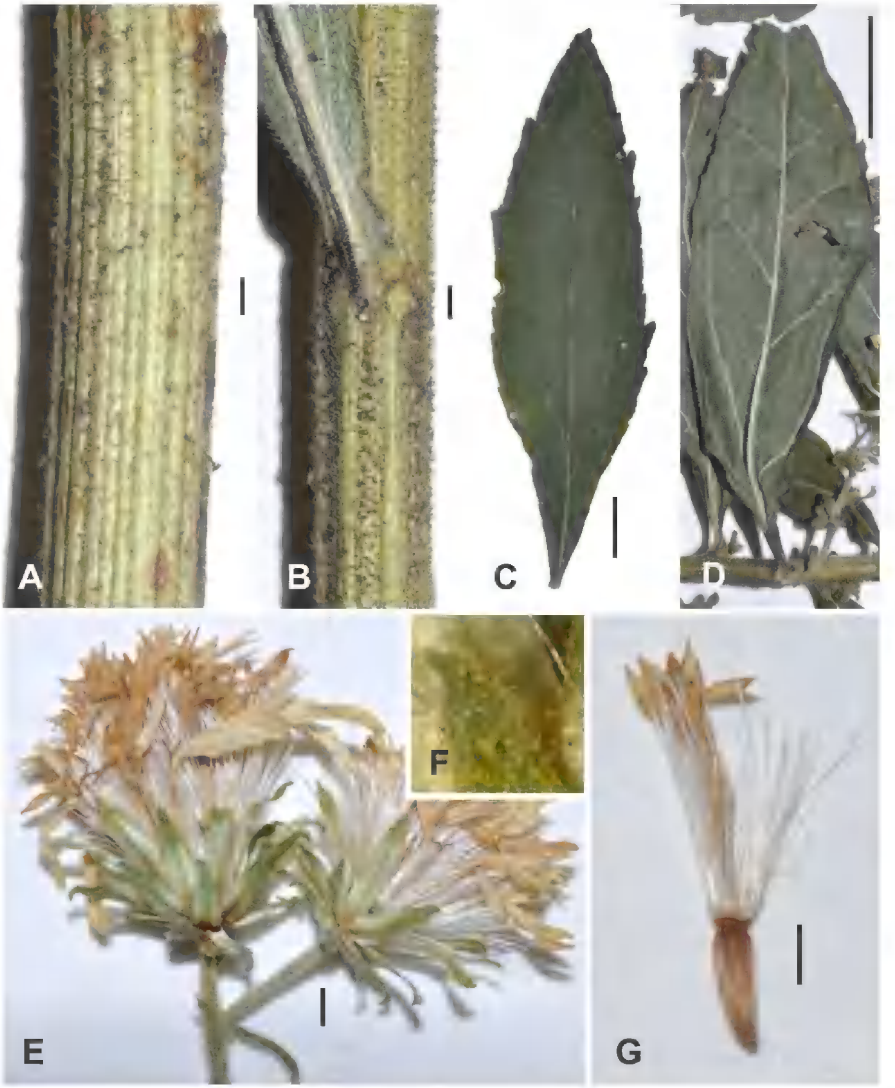

Figure 2. Details of morphology of *Solidago buckleyi* from Alabama: *Keener 4013* (WAT). **A**. Lower stem. **B.** Mid stem. **C.** Mid stem leaf , adaxial surface. **D.** Upper stem leaf in inflorescence, abaxial surface. **E.** Flowering heads. **F.** Mid series phyllary tip with stalked glands and strigose hairs. **G.** Developing cypsela with post anthesis disc corolla. Scale bar = 1 cm in C, D; = 1 mm in A, B, E, and G.

western Indiana, and western Kentucky (Semple & Cook 2006; Semple continuously updated). *Solidago buckleyi* has been recognized as a species separate from *S. petiolaris* Ait. by authors since it was first described, although difficulties in distinguishing it from *S. petiolaris* have often been noted

(Steyermark 1963; Cronquist 1968, 1980; Nesom 1993; Weakley 2015; Yatskievych 2006). Nesom (1990) discussed the history of the application of the name and provided a key to separate *S. petiolaris* and *S. buckleyi*.

Semple and Gandhi (2012) discussed the problems with typification of the name *Solidago buckleyi* and proposed a neotype for *S. buckleyi* (*E.J. Palmer 31579*, NY) because they believed that the single *S.B. Buckleyi s.n.* (NY) collection consisting of fragments was not the specimen on which Torrey and Gray (1942) had based their description and could not be the holotype. The only *Buckley s.n.* collection (NY ex Herb. LeRoy) consists of a few fragments and has the label data "Ala. 1838" and was included in a purchase of specimens to the NY herbarium 1896. Torrey and Gray must have had another source for the giving the location as "the interior" of Alabama and potentially a more complete shoot. If *Buckley s.n.* (NY ex Herb. LeRoy) is accepted as the holotype, then taxonomists are left with such an incomplete set of fragments typifying the species that application of the name is very ambiguous. The collection of *Keener 4013* (UWAL, WAT) provides a complete specimen from Alabama that can be used in a multivariate analysis and this is reported below. A manuscript on a multivariate study of all taxa in subsect. *Thyrsiflorae* is in preparation by the Semple Astereae Lab.

Multivariate analyses — materials and methods

In total, 52 specimens from GA, MO, NY, and WAT in MT (Thiers, continuously updated) were selected for inclusion in the analysis of the two species of subsect. *Thyrsiflorae* (18 specimens of *Solidago buckleyi* and 23 of *S. petiolaris* var. *petiolaris*) plus 11 *S. porteri* of subsect. *Squarrosae*. The 20 traits scored and included in the analysis are listed in Table 1. Only var. *petiolaris* occurs in Alabama (e.g., Nesom 2008) and is the sympatric taxon in subsect. *Thyrsiflorae* that can be very similar to *S. buckleyi*; specimens of var. *petiolaris* came from Alabama, Georgia, Florida, North Carolina, South Carolina, and Texas. Specimens of *S. porteri* from Alabama, Georgia, and Tennessee were included in the analysis because the mid and upper stem leaves can be similar in shape and serration traits to those of *S. buckleyi*. All the *S. porteri* specimens had large lower stem leaves present, while specimens of *S. buckley* and *S. petiolaris* were lacking basal stem leaves. All specimens of *S. petiolaris* have mid stem leaves with a distinctive short petiole (1-2 mm long) while mid stem leaves of *S. buckleyi* and *S. porteri* have tapering leaf bases and lack the distinct short petiole. *Keener 4013* (WAT) was included in the *S. buckleyi* a priori group in the analysis because it appeared to be most similar to *S. buckleyi* collections from elsewhere in the range and less so to *S. petiolaris* and *S. porteri* collections. Traits used to define a priori groups were not included in the analyses to avoid circular logic.

All analyses were performed using SYSTAT v.10 (SPSS 2000) following the methods of Semple et al. (2013, 2015).

Table 1. Traits scored for the multivariate analyses of 52 specimens of the taxa *Solidago buckleyi*, *S. petiolaris* var. *petiolaris*, and *S. porteri*.

Trait	Description
MLFLN	Mid stem leaf length
MLFWD	Mid stem leaf width at widest point
MLFWTOE	Length of mid stem from widest point to distal end of the leaf
MLFSER	Number of serrations along one side of the mid stem leaf margin
UPLFLN	Upper leaf length
UPLFWD	Upper leaf width at widest point
UPLFWTOE	Length of upper stem from widest point to distal end of the leaf
UPLFSER	Number of serrations along on side of the upper leaf margin

INVOLHT	Height of the involucre
RAYS	Number of ray florets in a head
OPHYLLN	Outer phyllary length
RAYLN	Length of the ray floret lamina
RAYWD	Width of the ray floret lamina
RACHLN	Length of the ray floret cypsela body at anthesis
RPAPLN	Length of the longest ray floret pappus bristle
DISCS	Number of disc florets in a head
DCORLN	Length of the disc floret corolla including lobes
DLOBLN	Length of the disc floret corolla lobes
DACHLN	Length of the disc floret cypsela body at anthesis
DPAPLN	Length of longest disc floret pappus bristle

Multivariate analyses –– results

In the STEPWISE discriminant analysis of three species-level a priori groups *Solidago buckleyi*, *S. petiolaris* (var. *petiolaris* only), and *S. porteri*, the following traits listed in order of decreasing F-to-remove values were selected (F-to-remove): mid leaf serrations (16.27), mid leaf length (14.52), ray floret pappus length (10.02), ray floret strap length (8.88), mid leaf width (5.80), upper leaf length (5.28), and disc floret lobe length (4.31). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicate the largest separations using the characters listed above were between *Solidago buckleyi* and *S. petiolaris* and between *S. petiolaris* and *S. porteri* (16.090 and 15.193 respectively). The smallest separation was between *S. buckleyi* and *S. porteri* (8.809).

Table 2. Between groups F-matrix for the five a priori group analysis (df = 7, 43).

Group	*buckleyi*	*petiolaris*	*porteri*
buckleyi	0.000		
petiolaris	16.090	0.000	
porteri	8.809	15.193	0.000

Wilks' Lambda = 0.1016 df = 7 2 49
Approx. F= 13.1288 df = 14 86 prob = 0.0000

In the Classificatory Discriminant Analysis of the three a priori groups the percents of correct classification were 89% for *S. buckleyi*, and 100% for *S. petiolaris* and *S. porteri*. The Classification matrix and Jackknife classification matrix are presented in Table 3. Results for individual a priori taxa are presented in alphabetical order of species. (1) Sixteen of the 18 specimens of *S. buckleyi* were placed a posteriori in *S. buckleyi* (11 with 97-100% probability, two with 90-95% probability, one with 78% probability, and one with 39% probability and 35% and 26% probabilities to *S. petiolaris* and *S. porteri*, respectively). The Alabama collection of *S. buckleyi Keener 4013* WAT was placed a posteriori in *S. buckleyi* with 100% probability. Two specimens were placed in *S. petiolaris* with 94% probability and 51% probability (47% to *S. buckleyi*). (2) All 23 specimens of *S. petiolaris* were placed a posteriori in *S. petiolaris* (21 with 98-100% probability, one with 87%, and one with 59% probability to *S. petiolaris* and 23% and 18% probabilities to *S. buckleyi* and *S. porteri*, respectively). (3) All 11 specimens of *S. porteri* were placed a posteriori into *S. porteri* (seven with 98-100% probability, two with 89% probability, one with 81% probability, and one with 48%

probability to *S. porteri* and 41% and 11% probability to *S. petiolaris* and *S. buckleyi*, respectively). In the Jackknife classification there was a drop in mean correct placement from 96% to 87% correct a posteriori placement to a priori group.

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Linear classification matrix

	buckleyi	***petiolaris***	***porteri***	% correct
buckleyi	16	2	0	89%
petiolaris	0	23	0	100%
porteri	0	0	11	100%
Total	16	25	11	96%

Jackknifed classification matrix

	buckleyi	***petiolaris***	***porteri***	% correct
buckleyi	13	4	1	72%
petiolaris	0	22	1	96%
porteri	0	1	10	91%
Total	13	27	12	87%

Two dimensional plots of scores of CAN1 versus CAN2 of *Solidago buckleyi, S. petiolaris* var. *petiolaris*, and *S. porteri* are presented in Figure 3. Eigen values on the first two axes were 3.055 and 1.427.

Discussion

The results very strongly support the conclusion that *Keener 4013* (WAT) was correctly identified as *Solidago buckleyi.* Overall the three species separate well on the characters selected by the analysis to maximize the Mahalanobis distances between the group centroids of the three species in N-dimensional hyperspace. There was a low level of incorrect assignment with weak to moderate probability of correct placement and an even lower level of a posteriori placement to another species. Two of the 18 specimens of *S. buckleyi* were placed into *S. petiolaris* a posteriori, which is a reflection of the difficulty noted in some floristic treatments that the two species can be rather similar. One of the specimens *Semple & Suripto 9917* (WAT) from Oregon Co., Missouri, had damage to the upper shoot resulting in limited head formation, but the lower and mid stem leaves had well-developed serrations and long tapering bases, and even the upper stem leaves had some serrations. Assignment to another species in the a posteriori classification analysis is likely the result of aberrant head traits due to the damage because the leaves are typical of *S. buckleyi.* Leaving the specimen out of the analysis because it was damaged would improve the results, but the reality is that herbarium specimens are sometime damaged and still need to be identified. Including them in an analysis gives taxonomists an indication of what technical traits are altered by damage besides those traits obviously effected by the damage. The second specimen of *S. buckleyi* assigned a posteriori to *S. petiolaris* was *Semple & Suripto 9878* (WAT) from Union Co., Illinois. Its lower mid stem leaves are large and broadly oblanceolate with a long tapering bases and large serrations on the upper margins; again typical of *S. buckleyi.* The inflorescence does not appear to be damaged and the upper stem leaves and those subtending lower inflorescence branches have serrations. It is not clear why this specimen was placed into *S. petiolaris* on technical traits with 94% probability to that species. Both collections were made in the same year so perhaps unknown environmental factors that year resulted in the development of atypical technical features. The one specimen of *S. porteri* assigned to that species a

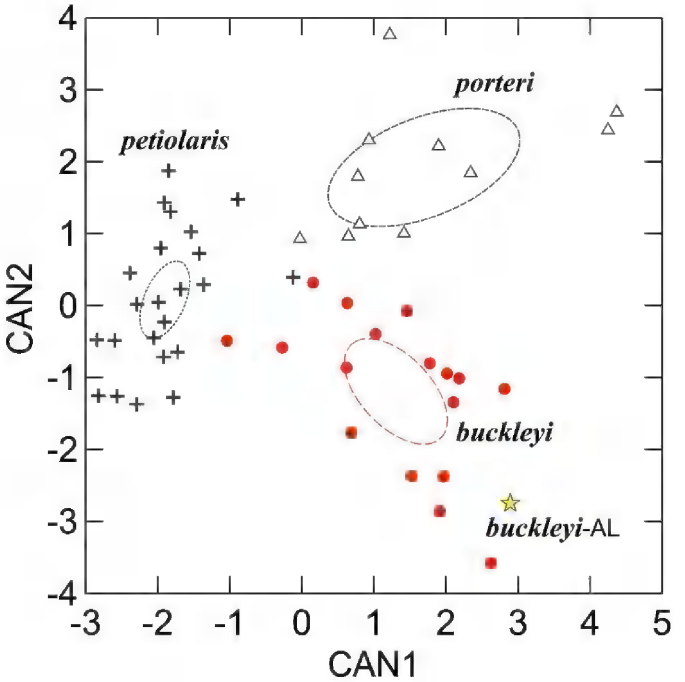

Figure 3. Plot of canonical variate scores (CAN1 and CAN2) of specimens of *Solidago buckleyi* (red dots), *S. petiolaris* (crosses) and *S. porteri* (open triangles). *Keener 4013* (WAT) from Alabama was included in the buckleyi a priori group in the multivariate analysis but is shown indicated by a star to emphasize its location in the diagram.

posteriori with low probability (46%) was *J. Semple & B. Semple 11190* (WAT) from Morgan Co., Alabama, the only known collection of the species from the state (Semple & Estes 2014). The specimen was hexaploid like the Tennessee population of *S. porteri*. The listing of $2n = 54$ for *S. petiolaris* in Flora North America (Semple & Cook 2006) was based on this collection, which Semple and Estes (2014) noted was collected and identified in the field incorrectly as *S. petiolaris* var. *petiolaris*. The largest leaves on the plants are the lower stem leaves typical of *S. porteri* and all of subsect. *Squarrosae*. On technical traits it converges with those of *S. petiolaris*. In 2003 when the specimen was collected the first author of this paper was significantly lacking in knowledge of *S. porteri*. Now, the specimen can clearly be identified as *S. porteri* on all general features.

ACKNOWLEDGEMENTS

This work was supported by a Natural Sciences and Engineering Research Council of Canada Operating and Discovery Grants to the JCS. Joan Venn is thanked for her curatorial assistance with loans to WAT. The following herbaria are thanked for loaning specimens of *Solidago* subsect. *Thyrsiflorae*: GA, MO, and NY. The following students assisted in recording location data and collecting morphological data on specimens: Andrew Lam, Yunfei Ma, Urva Naik, Naomi Steenhof, and Lan Tong. Brenda Semple is thanked for assistance on field trips.

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Published 17 February 2016. ISSN 2153 733X

A NEW LECTOTYPE FOR *APIASTRUM ANGUSTIFOLIUM* VAR. *TENELLUM* NUTT. (APIACEAE)

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ABSTRACT

Apiastrum angustifolium var. *tenellum* Nutt. is lectotypified by a specimen from BM, collected by Nuttall in San Diego, California. Two prior lectotypifications are deemed ineffective as not being based on original material.

Article 9 of the International Code of Nomenclature, (ICN) is explicit in its guidelines for the designation of lectotypes. As stated in Art. 9.2: "A lectotype is a specimen or illustration designated from the original material as the nomenclatural type, … if no holotype was indicated at the time of publication, or if the holotype is missing …". Art. 9.3 expands those guidelines as follows: "Original material comprises the following elements: (a) those specimens and illustrations (both unpublished and published either prior to or together with the protologue) upon which it can be shown that the description or diagnosis validating the name was based … ."

Thomas Nuttall contributed many names and descriptions to Torrey & Gray's Flora of North America 1-2: 1838-1842. *Apiastrum angustifolium* Nutt. (Fl. N. Amer. 1(4) 644. 1840) was proposed therein from a collection cited from "St. Diego" [San Diego, California]. Immediately following that proposal, and on the same page, Nuttall described the variety *tenellum* Nutt. He cited no additional specimens. Nuttall was in San Diego for part of Apr. and May 1836.

Nesom, in Phytoneuron 87: 3. 2012 designated a lectotype specimen for the var. *tenellum* as follows: "*Apiastrum angustifolium* var. *tenellum* Nutt. ex Torr. & A. Gray, Fl. N. Amer. 1(4): 644. 1840. **TYPE:MEXICO**. **Baja California**. Cerro [Cedros] Island, Mar 1889, *E. Palmer s.n.* (probable holotype: PH 743994 digital image!)." That this specimen is not part of Nuttall's original material, and thus in conflict with Art. 9.2, is clear from its collection date of Mar. 1889; almost 50 years later than the species description published in 1840. This was later recognized by Nesom, and a new lectotype designated in Phytoneuron 89: 3. 2012: "*Apiastrum angustifolium* var. *tenellum* Nutt. in Torr. & Gray, Fl. N. Amer. 1(4): 644. 1840. **TYPE**: **USA**. **California**.[Los Angeles Co.]: Catalina [Santa Catalina Island], no other collection data (probable holotype: PH bar code 00025006 digital image!, mounted in lower left of sheet with 3 other collections").

The following discussion will show that this specimen is again not original material.

Nuttall visited California in spring 1836. As cited by McKelvey (1956), he was able to collect specimens at Monterey (March), Santa Barbara (April), San Pedro (2 days in April) and San Diego (April to early May). He returned to New England with his collections, later that year. It has been a source of confusion elsewhere that an article published in the Proceedings of the Philadelphia Academy of Natural Sciences (Nuttall 1848a), and later, with minor changes in the Journal of the Philadelphia Academy of Natural Sciences (Nuttall 1848b), entitled "Plants collected by Mr. William Gambel in the Rocky Mountains and Upper California" also contained a number of names based on Nuttall's own collections. Thus the identity of the original materials has occasionally been confused as to whether they were collected by Nuttall or Gambel. Gambel was first in California in 1841-1842.

He visited some of the same coastal localities as did Nuttall and his specimens were presented to Nuttall upon his return to New England in 1843. It is not known how Gambel communicated his collection localities to Nuttall, but all of the specimens of Gambel's seen by this author are labeled with one of Nuttall's standard specimen tickets, in Nuttall's hand with a collection location, name, but without date or collector's name. Whenever Nuttall's or Gambel's names are on the ticket or the specimen sheet itself, they appear to have been added at a later time and by a different person.

California specimens labeled by Nuttall to have come from Monterey, Santa Barbara, or San Pedro are difficult or impossible to determine as to whether they were collected by Nuttall or Gambel; however, specimens with the following locations can be so determined. (1) "St. Diego": these are all Nuttall collections as Gambel did not visit San Diego. (2) "St. Simeon": Gambel visited San Simeon in San Luis Obispo County, Nuttall did not. (3) "Catalina": Gambel is cited by McKelvey (page 737, 1956) as the first botanist to collect on Santa Catalina Island off the southern California coast, visiting there in February 1842. There is no evidence that Nuttall visited the island when he was in southern California in 1836; none of his names based on California collections published before the William Gambel article mention Catalina, and the lack of Catalina Island endemics among his collections is further evidence he never collected on the island.

Thus the second lectotype proposed by Nesom was not collected until February 1842, nearly two years after the publication of *Apiastrum angustifolium* var. *tenellum* Nutt. in T. & G., Fl. N. Am. 1: 1840, and so cannot be original material.

However, there is a specimen at the British Museum that is labeled in Nuttall's hand "Apiastrum tenellum, St. Diego, U. Cal." The specimen matches well the protologue description. It has also been annotated anonymously as "Type Specimen" of *Apiastrum angustifolium* var. *tenellum* Nutt. That this is original material is supported by the collection locality being a site visited by Nuttall in 1836 from where he collected and named many plant species; the name written on a standard Nuttall ticket in his own hand; and with Nuttall's standard asterisk denoting a new taxon.

It would appear that rejection of the lectotype proposed by Nesom in Phytoneuron 89: 3. 2012, is justified. The following new lectotypification is offered (Fig. 1):

Apiastrum angustifolium var. *tenellum* Nutt. in Torr. & A. Gray, Fl. N. Amer. 1(4): 644. 1840. LECTOTYPE: **USA. California**.[San Diego Co.]: "St. Diego, U. Cal." Apr.-May 1836, *T. Nuttall s.n.* (BM 001042898 digital image!, Fig. 1).

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Nuttall, T. 1848b. Descriptions of plants collected by William Gambel M.D. in the Rocky Mountains and Upper California. J. Acad. Nat. Sci. Philad. n.s. 1: 149–189.

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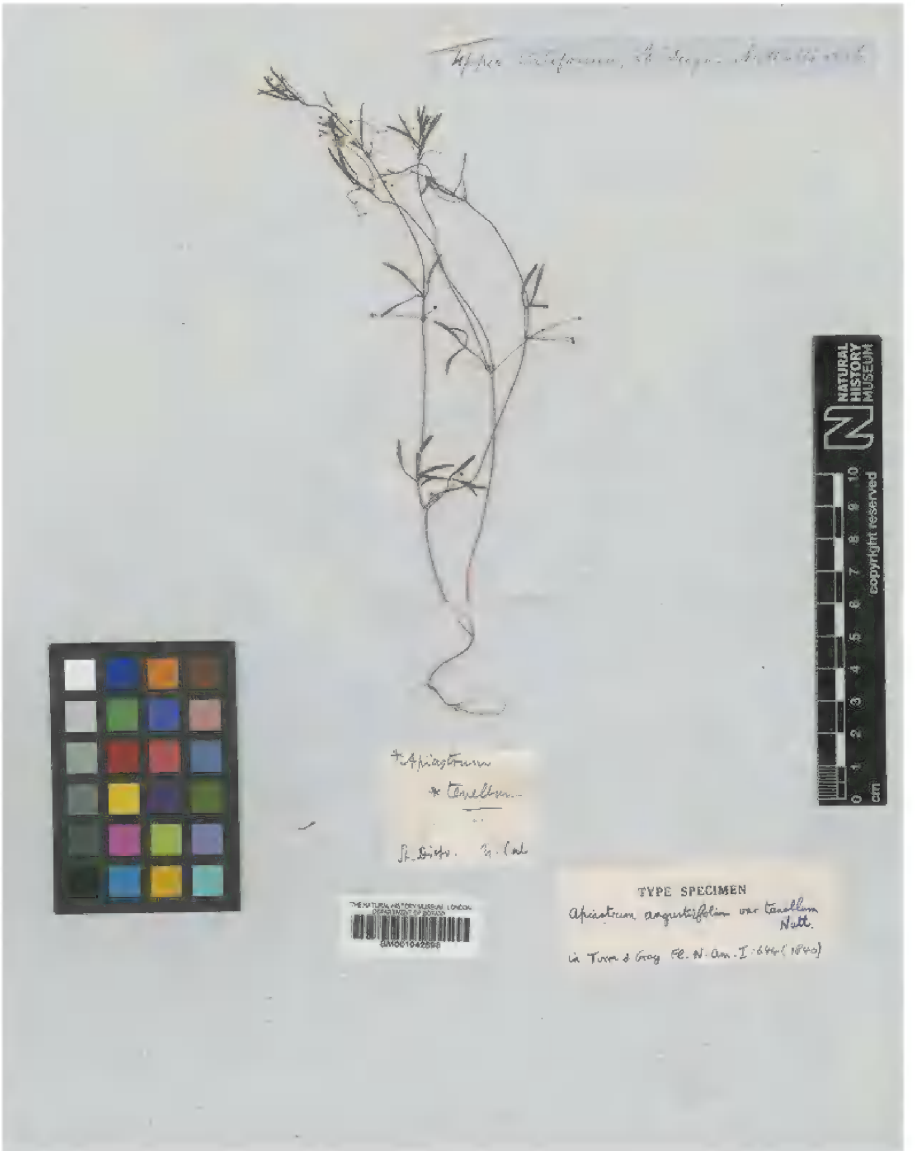
TYPE SPECIMEN
Apiastrum angustifolium var tenellum Nutt.
in Torr & Gray Fl. N. Am. I: 644 (1840)
NATURAL HISTORY MUSEUM
copyright reserved

Figure 1. Lectotype of *Apiastrum angustifolium* var. *tenellum* Nutt., Fl. N. Amer. 1(4): 644. 1840. BM 001042898 (JSTOR digital image).

Eckel, P.M. 2016. Annotated state and county checklist of the mosses of Wyoming, Part 1, A–L. Phytoneuron 2016-17: 1–123. Published 3 March 2016. ISSN 2153 733X

ANNOTATED STATE AND COUNTY CHECKLIST OF THE MOSSES OF WYOMING, PART 1, A–L

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ABSTRACT

This state and county checklist of the species of mosses known for Wyoming includes literature reports, lists of representative specimens examined, taxonomic and floristic annotations, and illustrations from the Flora of North America volumes 27 and 28. The account includes 380 species plus seven varieties.

Past checklists of the mosses of the state of Wyoming include those of Nelson (1900), Porter (1937, unpublished dissertation), and Eckel (1996). Additional papers of floristic importance are listed in the Wyoming Mosses Bibliography. A detailed summary of collecting activity and early floristic publications is given by Eckel (1996).

Continuing work on the state flora since 1996 by many bryologists and recent changes in classification introduced with the Flora of North America (FNA 2007, 2014) make a new compilation worthwhile. The most recent checklist of Eckel (1996) included 290 species plus 25 varieties, while the present list cites 380 species plus seven varieties. This reflects both new work and less emphasis on infraspecific taxa by authors of treatments in the Flora of North America.

The nomenclature follows that of the Flora of North America. Synonyms, largely from that work, are provided to help interpret names on specimens. The entries include a paragraph for nomenclature, another referencing the literature including discussion of geographic distribution largely based on information given by FNA and by Lawton (1971), a third paragraph citing specimens examined by myself, and a fourth with discussion. Herbarium citations are standard. Synonymy associated with prior lists is helpfully interspersed in Roman typeface. A left-aligned bar introduces new generic names.

Illustrations from volumes 27 and 28 of the Flora of North America (FNA 2007, 2014) are provided for many of the taxa in this list with the approval of the FNA Association. All of these were drawn by myself as illustrator of these two volumes.

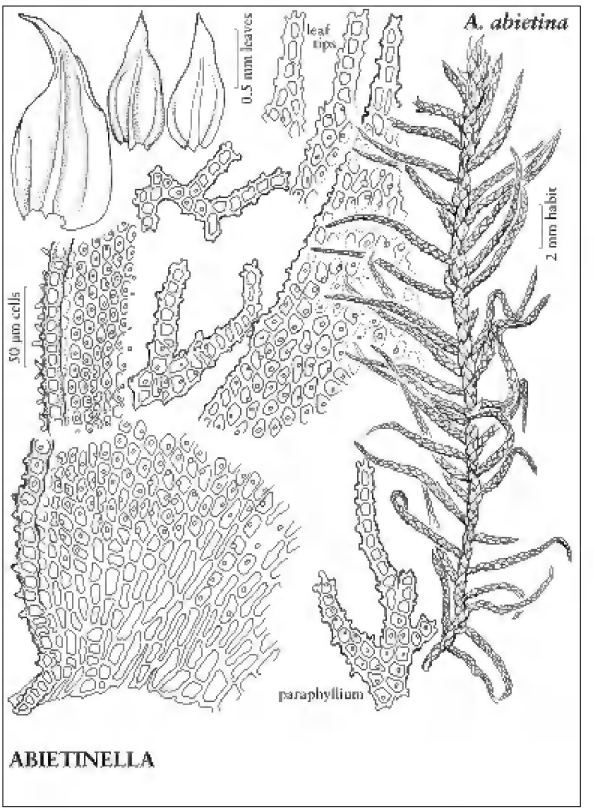
ABIETINELLA Müll. Hal., Nuovo Giorn. Bot. Ital., n.s. 3: 115. 1896. (Thuidiaceae)
Thuidium sect. Abietina Schimp.
Thuidium subg. *Abietinella* (Müll. Hal.) Broth.

Abietinella abietina (Hedw.) Fleischer, Musc. Buitenzorg 4: 1497. 1923.
Hypnum abietinum Hedw., Sp. Musc. Frond., 353 (added post-publ.). 1801.
Thuidium abietinum (Hedw.) B.S.G.

Wyoming; "Unlike *Thuidium*, *Abietinella* is papillose on both leaf surfaces rather than just the back" (W. R. Buck in FNA 28, 2014). Hawk's Ranch, Colorado-Wyoming State line, Albany

County (Nelson in 1930); Tower Falls, Yellowstone Natl Park (collector unknown), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Johnson Co.: Big Horn Mts., 5500 ft, *Odasz 1217* (BUF, RM). Park Co.: 6000 ft, *s.n. 13064* (RM, BUF); 6300–6900 ft, *21985* (BUF, RM). Sheridan Co.: Mineral soil, conifer litter, Big Horn Natl Forest, T57N, R89W, Sect. 28, 17 Jun 1992, *McGee 92–033* (BUF, RM). Weston Co.: Newcastle, on ground in open pine forest, 19 Jul 1942, *Degener 17,010* (NY). Yellowstone Natl Park: Beaver dams, Camp Roosevelt, 1924, *Conard VI*, c.fr. (NY).



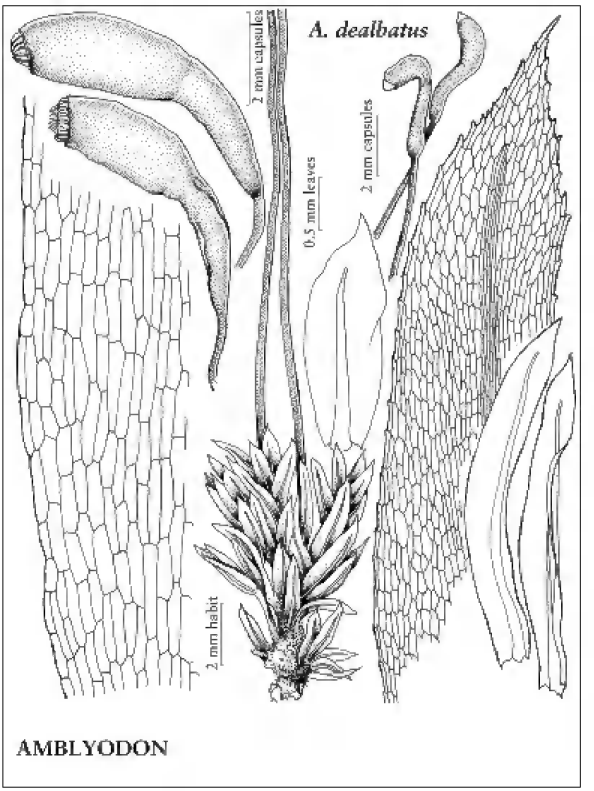
Courtesy FNA Association, FNA 28, 2014

AMBLYODON P.-Beauv., Mag. Encycl. 5: 323. 1804 (as Amblyodum), name and orthography conserved. (Meesiaceae).

Amblyodon dealbatus (Hedw.) P.-Beauv. in F. Cuvier, Dict. Sci. Nat. 2: 23. 1804 (as *Amblyodum dealbatum*).
Meesia dealbata Hedw., Sp. Musc. Frond., 174, plate 41, figs. 6–9. 1801.

Wyoming (FNA 28, 2014). Springy and boggy places, in the Ferris Mountains, Carbon Co. (*Nelson 4976*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: S slope of Bear Tooth Butte, 23 Aug 1953, *Lawton 2057* c.fr. (WTU).



Courtesy FNA Association, FNA 28, 2014

Amblystegium riparium (Hedw.) Schimp. = Leptodictyum riparium (Hedw.) Warnst.

AMBLYSTEGIUM Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 45, plates 561–566, 568–573. 1853. (Amblystegiaceae)

Amblystegium serpens (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 53. 1853.
Hypnum serpens Hedw., Sp. Musc. Frond., 268. 1801.
Amblystegium juratzkanum Schimper
Amblystegium serpens var. *juratzkanum* (Schimper) Rau & Hervey

Wyoming (FNA Vol. 28, 2014). (As var. *serpens*:) Wyoming: Yellowstone Natl Park (*1550b–1552*) (Roell 1893). Yellowstone is the type locality for *A. serpens* subspecies *schlotthaueri*

Ren. & Card. (*1550*) described in Roell (1893). (As *Amblystegium schlotthaueri* (Ren. et Card.) Par. = *A. serpens* (Hedw.) BSG fid. Cheney, Bot. Gaz. 24:241. 1897.) "on wet rocks in Yellowstone Nat. Park, Wyom." (*Roell 1893*). Albany, Carbon Cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: "Laramie Hills" *Nelson 1929* (RM); Medicine Bow Mts., Medicine Bow Natl Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, *Pinus contorta* forest along Libby Creek, 2660 m, *Buck 23189* (NY); NW base Sheep Mtn. along WY Rte. 11, ca. 4 mi ESE of Centennial, 7,700–7,800 ft, fen with low forest of *Populus, Betula, Salix,* in shallow water, a "hanging bog" on steep hillside, wet rotting log, *Reese 18173* (LAF, BUF). Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6,600 ft, *Elliott 1738* (BUF).

(As var. *juratzkanum*) Albany, Carbon, (Sublette, Teton Cos.), Yellowstone Natl Park, Porter (1935).

Albany Co.: 8,000 ft, *Porter 1541* (RM). Carbon Co.: Ferris Mts., 25 Jul 1898, *Nelson 4979* (RM). Fremont Co.: 8600 ft, *Hermann 25307* (RM). Yellowstone Natl Park: grassy seep, swale, roots of *Salix*, 6,239 ft, a few mi from Mammoth Hot Springs on Road to Tower, 6 Jul 1995, *Eckel 95082823,* with *Brachythecium frigidum, Aulacomnium palustre, Bryoerythrophyllum recurvirostrum, Bryum pseudotriquetrum* var. *bimum, Distichium capillaceum, Drepanocladus aduncus* & *D. uncinatus, Leptobryum pyriforme, Plagiomnium rugicum, Plagiothecium denticulatum* (BUF).

Platydictya (costae not evident or very short), *Platygyrium* (costa short and double), and *Pterigynandrum* (costa short and double), and *Pylaisiella* (costae short and double) are similar. *Amblystegium serpens* and varieties and variations always have a costa strong to at least the middle of the leaf. Especially gracile forms may be misleading.

Amblystegium tenax (Hedw.) C. Jens. = Hygroamblystegium varium (Hedw.) Mönk. subsp. varium

Amblystegium trichopodium (Schultz) Hartm. = Hygroamblystegium varium (Hedw.) Mönk. subsp. varium

Amblystegium varium (Hedw.) Lindb. = Hygroamblystegium varium (Hedw.) Mönk., s.l.; q.v.

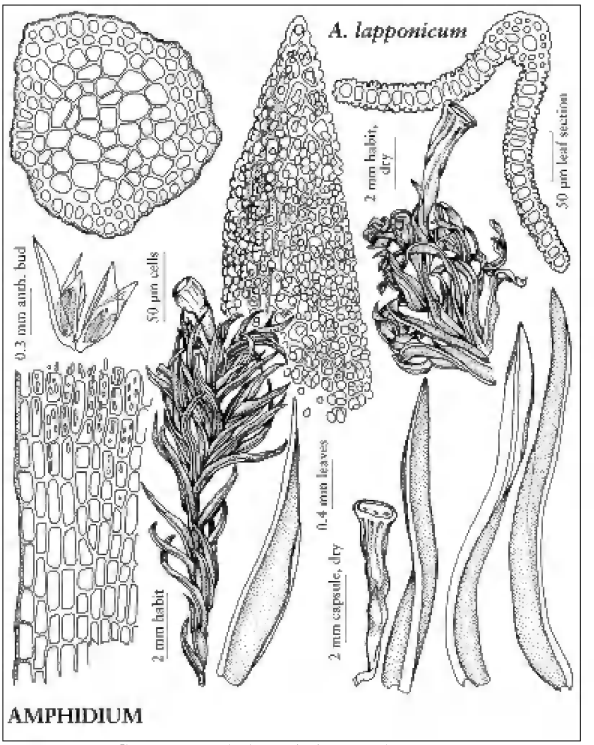
AMPHIDIUM Schimper, Coroll. Bryol. Eur., 39. 1856, name conserved. (Orthotrichaceae)

Amphidium lapponicum (Hedw.) Schimp., Coroll. Bryol. Eur., 39. 1856.
Anictangium lapponicum Hedw., Sp. Musc. Frond., 40. 1801 (Hedw.) Schimp.

Wyoming (FNA Vol. 28, 2014).

(As *Amphoridium lapponicum* Sch.) Wyoming: Yellowstone Natl Park, Upper Falls (*1460, 1472*), Roell (1893). Albany County (*Porter 1738*); Johnson Co. (*Porter 1624*), Porter (1935). Teton Co., Spence (1985).

Sublette Co.: 10,348 ft, *Rolson 85117* (CSU).



Courtesy FNA Association, FNA 28, 2014

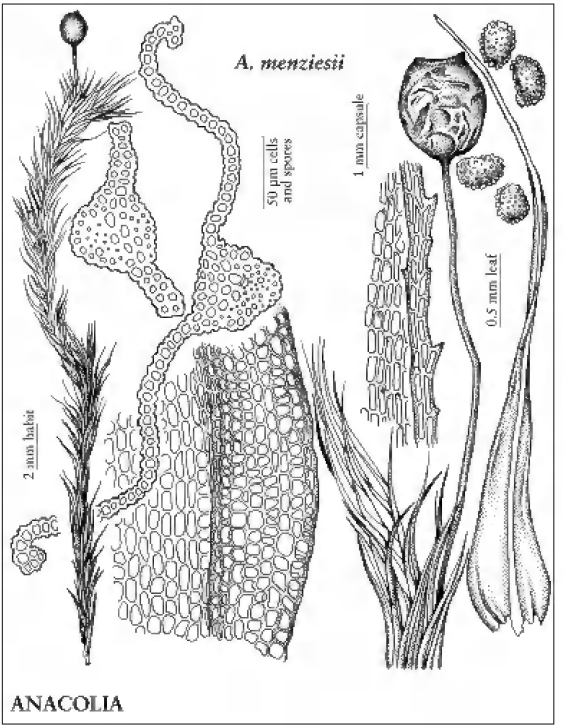
ANACOLIA W.P. Schimper, Syn. Musc. Eur. ed. 2, C, 513. 1876, name conserved. (Bartramiaceae)

Anacolia menziesii (Turner) Paris, Actes Soc. Linn. Bordeaux, sér. 5, 6: 37. 1894 (as menziezii).
Bartramia menziesii Turner, Ann. Bot. (König & Sims) 1: 525, plate 11, fig. 1. 1805.
Anacolia menziesii var. *baueri* (Hampe) Paris
Bartramia menziesii Turner

Wyoming (FNA Vol. 28, 2014). Wyoming, Lawton (1971). Wyoming, Flowers (1973).

Yellowstone Natl Park: Firehole River S of Madison Junction, 18 Aug 1953, *Lawton 1875* (WTU).

In the Eckel (1996) checklist there is a var. *baueri* (Hampe) Flow.



Courtesy FNA Association, FNA 28, 2014

ANDREAEA Hedw., Sp. Musc. Frond., 47. 1801. (Andreaeaceae)

Andreaea rupestris Hedw., Sp. Musc. Frond., 47, plate 7, fig. 2g–o. 1801.
Andreaea petrophila Fuernr.
NOTE: there numerous synonyms in FNA Vol. 28, 2014.

Reported for Wyoming (errata, FNA Vol. 28, 2014).

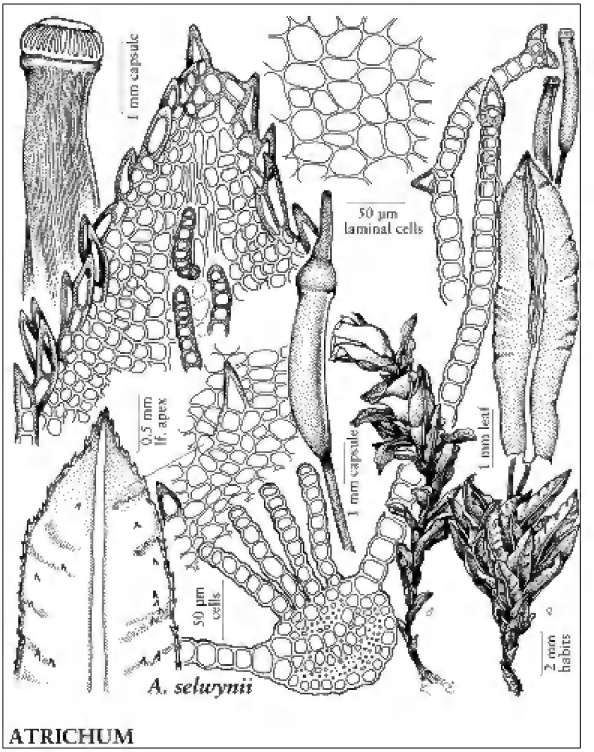
Yellowstone Natl Park: Lost Lake, *Lawton 1830* (YELLO).

ATRICHUM P. Beauv., Mag. Encycl. 5: 329. 1804, name conserved. (Polytrichaceae)

Atrichum selwynii Aust., Bot. Gaz. 2: 95. 1877.
Atrichum rosulatum Müll. Hal.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the P.N.; Alaska, California, Saskatchewan, Manitoba, Utah, Colorado (Lawton 1971). Teton Co. (Spence 1985).

Teton Co.: 7000', *Hermann 25548* (RM, US-two specimens).



Courtesy FNA Association, FNA 27, 2007

Atrichum undulatum (Hedw.) P.-Beauv., Prodr. Aethéogam., 42. 1805.
Polytrichum undulatum Hedw., Sp. Musc. Frond., 98. 1801.

Not reported for Wyoming in FNA: "No species occurring in North America has been as widely misunderstood as *A. undulatum.* Evidently introduced from Europe, its weed habitat and strongly arcuate, almost horizontal capsules are the surest means of recognition" (Merrill in FNA Vol. 27, 2007).

Teton Co.: Spence (1985).

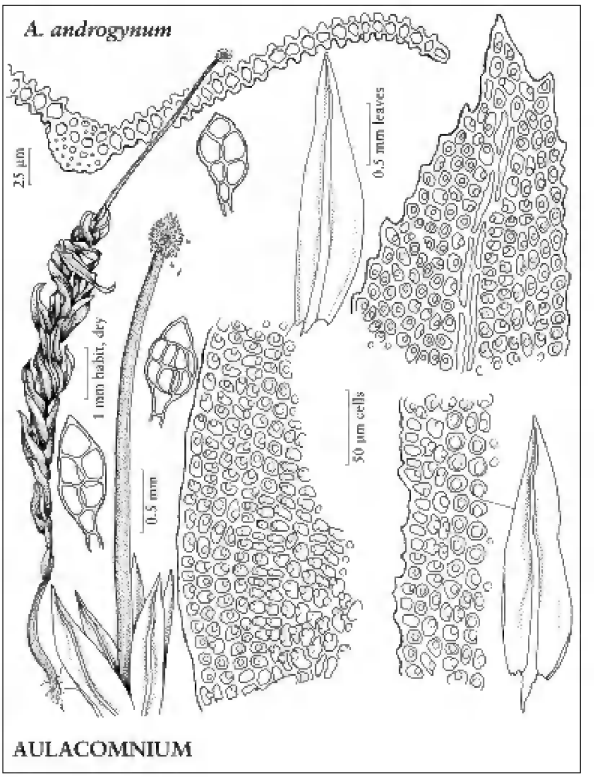
AULACOMNIUM Schwägr., Sp. Musc. Frond. Suppl. 3(1,1, Aulacomnion): 1, plates 215, 216. 1827, name and orthography conserved (as Aulacomnion). (Aulacomniaceae)

Aulacomnium androgynum (Hedw.) Schwägr., Sp. Musc. Frond. Suppl. 3(1,1,Aulacomnion): 2. 1827 (as Aulacomnion).
Bryum androgynum Hedw., Sp. Musc. Frond., 178. 1801.

Wyoming (FNA Vol. 28, 2014), Albany Co., Sublette Co., Teton Co., and Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985) citing Porter (l935) for Teton Co. Nelson (1900). Ireland (1982). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Crook Co.: Black Hills: Williams Spring area, 4 mi ENE of Alva; Sect. 36, T55N, R63W. conifer-deciduous woods, moss shaded on moist soil, 22 May 1977, *Churchill 8859* (TENN).

This plant is smaller than *A. palustre,* so naturally the leaves are shorter, they are not twisted and contorted as in the next. The cells at the base are not differentiated into large, hyaline to yellow cells, nor are they brown. The basal cells here are just like the laminal cells. If the propaguliferous stalks (pseudopodia) are present, they are naked of leaves or bracts and the propagula are clustered into a globose head.

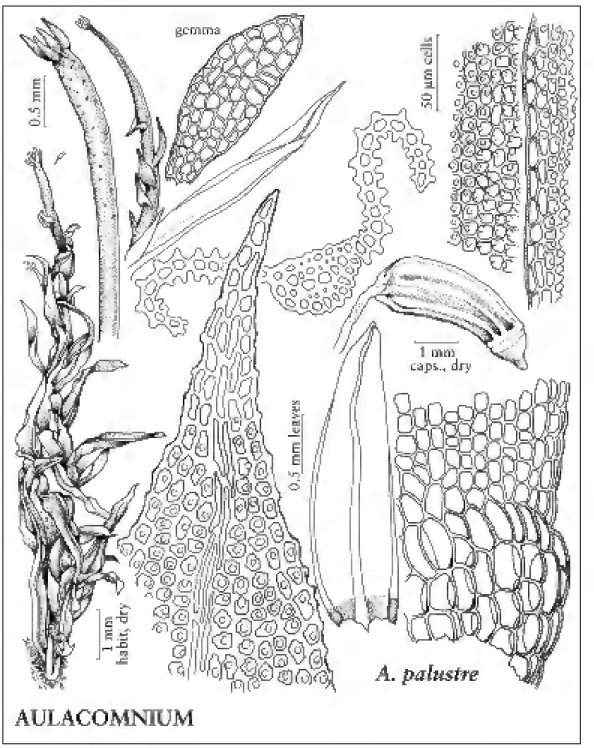


Courtesy FNA Association, FNA 28, 2014

Aulacomnium palustre (Hedw.) Schwägr., Sp. Musc. Frond. Suppl. 3(1,1, Aulacomnion): 4. 1827 (as Aulacomnion).
Mnium palustre Hedw., Sp. Musc. Frond. 188. 1801.
Gymnocybe palustris (Hedw.) Fries, nom. rejic.
Mnium palustre Hedw.

Mnium papillosum Müll. Hal.
Sphaerocephalus palustris (Hedw.) Lindb.

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park, 6000 ped. alt., sterile (*1523–25*), Roell (1893), "Albany, Sheridan, (Sublette, Teton Cos.), Yellowstone Natl Park, Porter (1935). Park Co.: with *Sphagnum warnstorfii, Campylopus schimperi,* Kosovich-Anderson (2011a). Teton Co., Spence (1985). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 27, 2007

Albany Co.: *Nelson 7820* (RM); *Nelson 8899* (RM); Medicine Bow Mts., in woodland bogs, 8–10000 ft, *Nelson 7820* (id'd by Holz. as *A. androgynum*) (TENN). Big Horn Co.: 10,000–10,800 ft, *Odasz 742* (RM); Big Horn Natl. Forest, Lake Solitude Quad., Cloud Peak Wilderness Area, 9,840 ft, filled in lake, Aug 5 1992, *Zacharkevics s.n.*, with *Drepanocladus aduncus aduncus, Warnstorfia exannulata* (BING). Carbon Co.: *Hermann 17804* (RM). Fremont Co.: 9300 ft, *Hermann 25293* (RM). Park Co.: 7500 ft, *Hermann 20060* (RM); Beartooth Pass, 10,000 ft, *Hermann 20073* (RM). Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1741* (BUF). Sheridan Co.: Dome Lake, *Nelson 2417* (RM); *Odasz 875* (BUF, RM). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1.5 mi E of Barnes Lake, 10,080 ft, 42°58'W, 109°34'W, sedge fen with *Bryum pseudotriquetrum, Philonotis*

fontana & *Drepanocladus exannulatus,* 17 May 1989, *Andrus 7871* (BING). Teton Co.: on US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000', *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus*, Asters, wooded stream, soggy debris, 6 Jul 1985, *Eckel 94082100*, c.fr., (BUF, RM). Yellowstone Natl Park: *Nelson & Nelson 6429* (RM), *6099* (RM). La Plata Mines, *Nelson* 5265 (RM).

When the propagula are gone, frequently the far distal end of the pseudopodium has tiny dark-brown points where the propagula were once attached and the "receptacle" is elongate. The "receptacle" of *A. androgynum*, when the propagulae are gone, is sharply and distinctly spherical. If they extend down a ways from the pseudopodium, this should indicate one is dealing with *A. palustre*, since its propagula are not confined to the tips. Examination of the leaf basal cells should confirm this; note that if large cells are not there, they were probably left on the stem when the leaf was removed.

Aulacomnium papillosum L. & J. Centennial, Albany County (*Nelson 1746*), Porter (1935) = *A. palustre* var. *papillosum* (Müll. Hal.) Podp. No reference to this variety is made in the Anderson et al. (1990) checklist. And no reference is made to this variety by Crum & Anderson (1981: 619).

BARBULA Hedw., Sp. Musc. Frond., 115. 1801, name conserved. (Pottiaceae)

Barbula convoluta Hedw., Sp. Musc. Frond., 120. 1801.

Var. **convoluta**

Barbula closteri Aust.
Barbula convoluta var. *obtusata* Müll. Hal. & Kindb.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007).

Albany Co.: *Hermann 17775 1\2*, 8500 ft, (RM).

Barbula unguiculata Hedw., Sp. Musc. Frond., 118. 1801.
Barbula unguiculata var. *apiculata* (Hedw.) Bruch, Schimper & Gümbel.

Wyoming (FNA Vol. 27, 2007). Rochelle Hills, Campbell Co., Medina (1994).

Albany Co.: along Roger Canyon in the Laramie Mtns, 7 mi, due NE of Laramie city center, *Artemesia* scrub vegetation, limestone cliffs and outcrops, 7,600 ft, soil below edge of limestone boulder, 7 Jun 1993, *Reese 18149* (BUF, LAF).

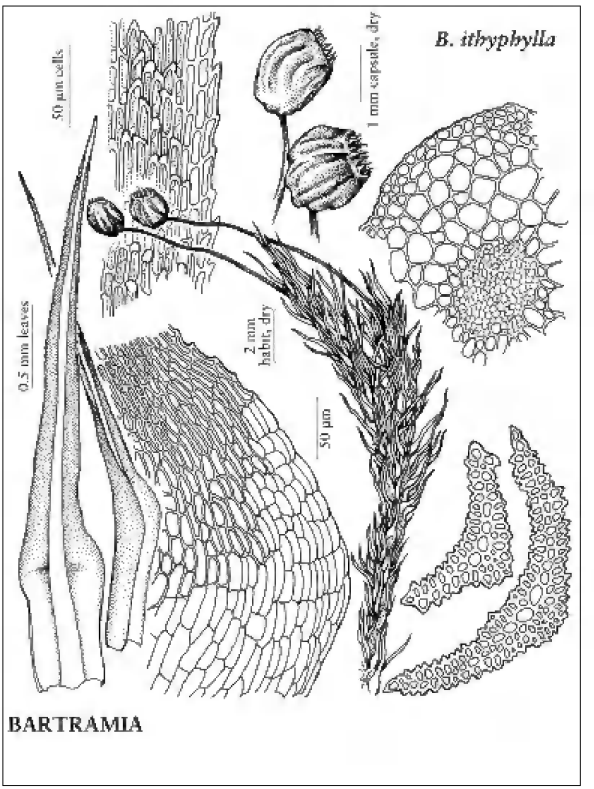
A specimen from Rochelle Hills, Campbell Co. from MO was redetermined to be *Bryoerythrophyllum recurvirostrum* (q.v.) (5–8 Jun 1975, *Weber s.n.*).

BARTRAMIA Hedw., Sp. Musc. Frond., 164. 1801, name conserved. (Bartramiaceae)

Bartramia ithyphylla Brid., Muscol. Recent. 2(3): 132, plate 1, fig. 6. 1803 (as Barthramia).
Bartramia ithyphylla var. *breviseta* (Lindb.) Kindb.
Bartramia ithyphylla subsp. *rigidula* (Lindb.) Kindb.

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park, c.fr., (*1494*), Roell (1893). Brooklyn Lake, Albany Co. (*Nelson 5177*), Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: , 10,800 ft, 3 Aug 1962, *Hermann 17715* (RM). Carbon Co.: 9000', 6 Aug 1962, *Hermann 17800* c.fr. (RM). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, with *Mnium thomsonii,* 14 May 1989, *Andrus 7787a* (BING).



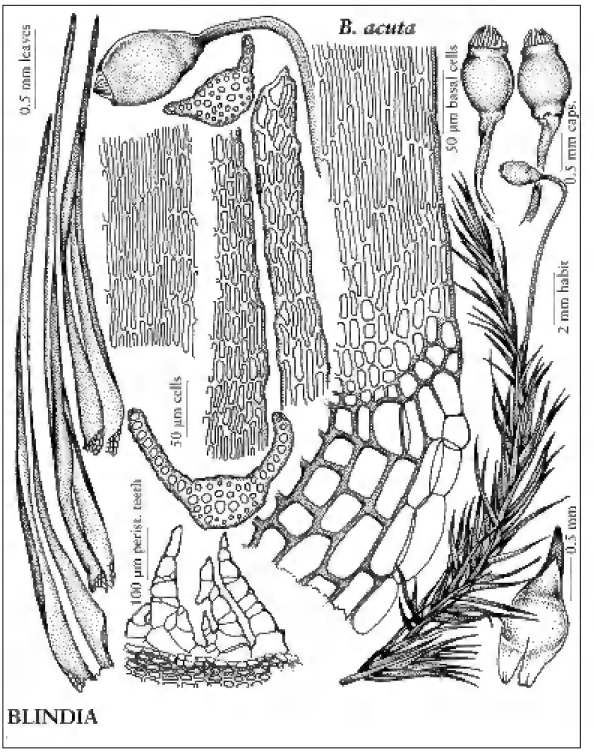
Courtesy FNA Association, FNA 27, 2007

BLINDIA P. Bruch & W.P. Schimper, Bryol. Europ. 2: 17. 1846. (Seligeriaceae)

Blindia acuta (Hedw.) P. Bruch & W.P. Schimper, Bryol. Europ. 2: 19. 1846.
Weissia acuta Hedw., Sp. Musc. Frond., 71. 1801.

Wyoming (FNA Vol. 27, 2007). Park Co., with *Philonotis yezoana*, q.v. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: 3200 m, *Weber, B–44312* (RM, COLO). Sublette Co.: above Upper Twin Lake, vicinity Pass Lake, Highline Trail between Summit Lake and Peak Lake, Jim Bridger Wilderness, Wind River Mts., 10,348 ft, *Rolston 84134* (BUF, CSU).



Courtesy FNA Association, FNA 27, 2007

Brachymenium vinosulum Card. = Plagiobryoides vinosula (Card.) J.R. Spence (FNA 28, 2014)

BRACHYTHECIASTRUM Ignatov & Huttunen, Arctoa 11: 259. 2003. (Brachytheciaceae)

This segregate from *Brachythecium* includes species noted for their "relatively small size, slender habit, and monoicous inflorescence," "the smooth seta," "the capsules inclined to horizontal" (not suberect and subcylindric, although they are in *B. fendleri*) and "by the drier habitat" (Flowers 1973). *Brachythecium erythrorrhizon* is still retained within *Brachythecium.* Such species were grouped infragenerically as the *velutinum* group or sect. *Velutina* De Not. (Ignatov 2014) before being given generic status. Other traditional species of *Brachythecium* are larger and characterized by a damp or wet habitat (Flowers 1973), whereas *Brachytheciastrum* species, together with *Homalothecium* species, with which those of *Brachytheciastrum* are allied, are among the most xerophytic in the Brachytheciaceae (Ignatov 2014). The sexual condition characterizing

Brachytheciastrum, as in *Sciuro-hypnum*, is autoicous (synoicous in *B. fendleri; dioicous in S. hylotapetum* and *S. latifolium*). The sexual condition of *Brachythecium* is either autoicous or dioicous.

Brachytheciastrum collinum (Schleicher ex Müll. Hal.) Ignatov & Huttunen, Arctoa 11: 260. 2003.
Hypnum collinum Schleicher ex Müll. Hal., Syn. Musc. Frond. 2: 429. 1851.
Brachythecium collinum (Schleicher ex Müll. Hal.) Schimp.
Brachythecium idahense Ren. & Card.
Hypnum hillebrandii Lesq.

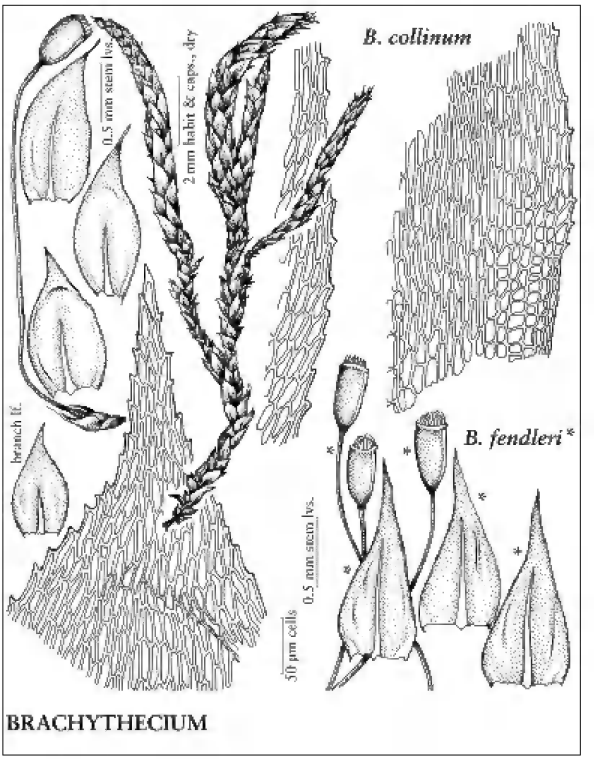
Wyoming (FNA Vol. 28, 2014). (As *Brachythecium collinum*:) Wyoming: Yellowstone Natl Park (*1540, 1548a, 1565a*), Roell (1893). (As *Brachythecium collinum*:) Albany, Carbon, Sublette, Teton Cos. and Yellowstone Natl Park, Porter (1935). Albany Co. (*Porter 680; 698; 651, 654)*, Yellowstone Natl Park (*Bartram and Smiley*), Porter (1934). Albany Co, Yellowstone Natl Park, Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Brachythecium collinum*:) Albany Co.: Laramie Mtns., Roger Canyon, ca. 8 air mi NE of Laramie, 2400 m, limestone outcrops with *Cercocarpus montanus*, *Buck 23168* (NY); S bank of Little Brooklyn Lake, Medicine Bow Mtns, 10,300 ft, 30 Jun 1949, *Schriever 14* (RM); Medicine Bow Mountains, Barber Lake Picnic area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest along stream, on soil, 7 Jun 1993, *Miller 10,256* (NYS). Bighorn Co.: on soil along small dry watercourse, moist area in subalpine forest with *Pinus contorta, Picea engelmannii, Vaccinium scoparium*; near Buckskin Ed Creek; ca. 3.5 air mi WNW of West Tensleep Lake; Bighorn Natl. Forest; with *Pohlia cruda* and *P. nutans,* UTM 13 317827 E 4905084 N, 2749 m, 27 Aug 2005, *Lenz 2233a* (RM). Carbon Co.: (minute form assoc. with water) Medicine Bow Natl Forest, Sierra Madre Mts., Lost Creek valley, Lost Creek Campground vicinity, roadside of Rd 70, young stands of *Pinus contorta*, on wet loamy and gravelly soil, in partial shade, not abundant, assoc.: *Ceratodon purpureus*, 8550–8600 ft, N 41°08.394', W 107°05.383', T14N R86W S32, 2 Jul 2011, *Kosovich-Anderson 9347* (RM). Fremont Co.: Bridger-Teton Natl Forest on US 26 & US 287, between Moran & Dubois, ca. 9000 ft, alpine meadow, much herbage, wet with flowing streams, soil between granite boulders, N slope knoll, 6 Jul 1985, *Eckel 94081301*, c.fr., (BUF, RM); Fremont Co. near border with Teton Co., between Moran and Dubois twps. on US 26, E of Togwotee pass, ca. 9000 ft at 63.0; S-facing; spruce and 2- & 5-needle pines, herbaceous, not species abundant slope, *Artemisia tridentata* here and there, on granite, with *Dicranoweisia crispula,* 6 Jul 1985, *Eckel s.n.* (BUF). Johnson Co.: *Eckel 14886* (BUF). Park Co.: Bear Tooth Plateau, Cooke City to Red Lodge Hwy; *Picea* forest with *Pinus flexilis* and *P. contorta, Vaccinium scoparium,* in duff on forest floor, *Weber B–44220* (COLO, RM). Sheridan Co.: on rock in stand of *Picea engelmannii* surrounding large limestone boulder; ca. 0.4 air mi NNE of high point of Sheep Mtn., Bighorn Natl. Forest, UTM 13 273014 E 4981050 N, 2864 m, 31 Aug 2006, *Lenz 3447* (RM). Teton Co.: E boundary of Teton Co., Continental Divide, Tworoger Pass, 9000 ft, on ground, 22 Jun 1931, *Frye s.n* (RM). Yellowstone Natl Park: in Norris Geyser Basin, 14 Aug 1925, *Frye s.n.,* (RM); stream bank on rock, on slope, 17 mi W of East Entrance, 29 Aug 1951, *Welch 14883* (YELLO).

Leaves have distinctively sharp serrations from apex to especially the quadrate cells in the basal angles. The leaf cells appear to be short, almost like *Amblystegium*, especially in the apex. Note the leaves are decurrent: care must be taken when removing the leaves. Like *Pseudoleskeella tectorum* (which has none to variable costae in the leaves), although the julaceous form in drier habitats is perhaps more readily come to hand, one must be careful of the shade forms, too. The costa in these is single and strong enough to separate from *P. tectorum* (with has generally entire margins, seldom fruits and has short cells as in *Amblystegium*). *Brachytheciastrum collinum* fruits in July. This species is separated from *B. velutinum* var. *venustum* by the smooth setae (although see Flowers

(1973) who indicates scattered papillae), but more importantly the broadly ovate-lanceolate character of the leaves with their abrupt acumination. Flowers (1973) also indicated that *B. velutinum* var. *venustum* has "perichaetial leaves slenderly-long acuminate, often hairlike," which *B. collinum* does not have; the variety also has narrower leaves overall. The shade form of *B. collinum* is not particularly concave in leaves on the slide, although they appear this way on the stem.

Brachytheciastrum collinum may be more associated with humus and litter, rotten wood than var. *venustum* which seems to prefer soil and rock. Weber & Wittmann's (2007) thought that *B. collinum* and *B. velutinum* may be variants of one another seems credible. Note somewhat julaceous habit of *B. fendleri* that may be confused with this species. *Brachytheciastrum fendleri* has distinctive upright fruit, whereas *Brachytheciastrum collinum* has capsules that are horizontal; B. *collinum* is abruptly acuminate, while *B. fendleri* is "gradually to narrowly acuminate, sometimes very slenderly so" Flowers (1973: 430).



Courtesy FNA Association, FNA 28, 2014

Brachytheciastrum fendleri (Sull.) Ochyra & Żarnowiec, Biodivers. Poland 3: 172. 2003.
Leskea fendleri Sull., Mem. Amer. Acad. Arts, n. s. 4:169, plate 1. 1849.
Brachythecium fendleri (Sull.) A. Jaeger
Brachythecium utahense James in Watson
Hypnum fendleri (Sull.) Sull. & Lesq.

Wyoming (FNA Vol. 28, 2014). (As *Brachythecium fendleri*:) (earlier as *Brachythecium utahense* James) Albany Co. *(Porter 1442; 637*); Carbon Co. (*Porter 908*), Yellowstone Natl Park (*Smiley*), Porter (1934). (As *Brachythecium utahense* James) Albany County, Carbon County, and Yellowstone Natl Park, Porter (1935). (As *Brachythecium utahense* James) Albany, Carbon Cos., Yellowstone Natl Park, Porter (1937). Southern Wyoming, Flowers (1973). Teton Co., Spence (1985). Campbell Co., Medina (1994).

(As *Brachythecium fendleri:*) Albany Co.: Centennial Hills, 20 Aug 1896, *Nelson 2716* c.fr. (RM).

(As *Brachythecium fendleri*) This rather diminutive *Brachythecium* is distinctive in its upright straight capsules what are longer and narrower than typical for the genus. Its small size puts it in Flower's (1973) *B. collinum* group (*fendleri, delicatulum, suberythrorrhizon* (= *velutinum* var. *venustum*), *erythrorrhizon*). It is also distinctive in its synoicous inflorescences. Without fruit they look remarkably like *B. collinum*. *Brachythecium fendleri* is sharply toothed, even to the base and in an Arizona specimen has spoon-shaped leaves especially at the leaf base (*MacFadden 8009* det. Grout from Grand Canyon, at RM). Note that the leaves appear broadly recurved-naviculate on one side at the leaf base.

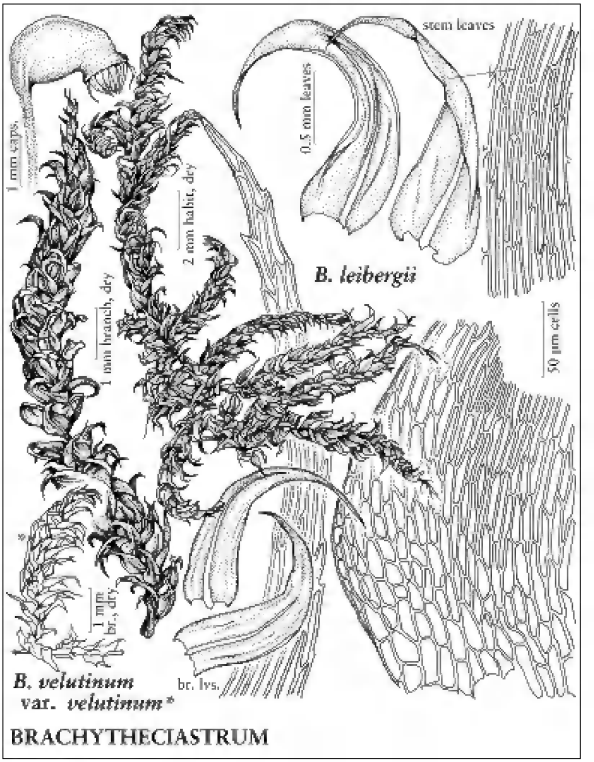
The *2716* specimen has *coarse*, sharp serrate teeth to the leaf base, with shortened cells in the apex and occasionally rostrate opercula, but what else could be synoicous as this specimen robustly is? And the cilia are short while the endostome matches the exostome teeth. Teeth and short apical cells are distinctive in branch leaves.

Brachytheciastrum leibergii (Grout) Ignatov & Huttunen, Arctoa 11: 260. 2003.
Brachythecium leibergii Grout, Mem. Torrey Bot. Club 6: 197. 1897.

Wyoming (FNA Vol. 28, 2014).

(As *Brachythecium leibergii*) Albany Co.: Medicine Bow Mountains, Medicine Bow Natl Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, 2660 m, *Pinus contorta* forest along Libby Creek, 7 Jun 1993, *Buck 23202* (setae detaching, old), with *Ceratodon purpureus, Distichium capillaceum* (NY). Carbon Co.: on wet rock at edge of Trail Creek, W of Sand Lake Rd., 9000 ft, Medicine Bow Mts., 4 1/2 SW Morgan, Aug 6 1962, *Hermann 17808*) (sterile, based on pinnate branching, serrations, plications, decurrencies, robust, etc.) det. by Robinson (RM, US). Yellowstone Natl Park: Old Cooke Ranger Station, 31 Aug 1948, *Conard 48–282*) (det. as *B. glareosum,* autoicous) (YELLO); E slope along old road above Crescent Hill, 3 Sep 1948, *Conard 48–253* (det. as *B. glareosum*, autoicous) (YELLO).

This is a beautiful, robust moss with clearly pinnate branching except for multiple branching supporting gametoecia. Leaves are serrate and seta roughened; leaves are falcate, even when removed from the stem, clearly plicate wet or dry. The plant is very robust, compared to other pleurocarps in mixed collections. The shoulders of the leaf are lower than other species of the genus, it seems, and the strong serrations are striking. The papillae are tiny, sharp and distant on the seta. The homomallous character need not be strong — some leaves can be straight. The alar cells are numerous, quadrate, alar areas can be excavate. In both of the Yellowstone specimens (Conard) long lengths of stem material stripped away along with the decurrencies. These specimens were irregularly pinnate and resemble large forms of *B. velutinum* (note coarse serrations like *B. collinum*—a continuous gradation?). Branch leaves are coarsely serrate (not serrulate), reminiscent of the serrations on *B. collinum*.



Courtesy FNA Association, FNA 28, 2014

Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen, Arctoa 11: 260. 2003.
Hypnum velutinum Hedw., Sp. Musc. Frond., 272. 1801.

Var. **velutinum**
Brachythecium collinum var. *idahense* (Ren.& Card.) Grout
Brachythecium idahense Ren. & Card.
Brachythecium petrophilum R.S. Williams
Hypnum velutinum Hedw.

The var. *velutinum* has not been found in Wyoming according to FNA (Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Brachythecium velutinum)* Yellowstone Natl Park (*Smiley*), Porter (1934). Lake and Canyon, Yellowstone Natl Park (*Smiley*), Porter (1935); Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Ireland (1982).

The typical variety is said to have setae roughened by large papillae throughout, whereas the var. *salicinum (*as var. *venustum)* has them smooth or slightly rough at the base (Lawton 1971).

Var. **salicinum** (Schimper) Ochyra & Żarnowiec, Biodivers. Poland 3: 172. 2003.

Brachythecium salicinum Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 19, pl. 548. 1853.
Brachythecium olympicum Jur. in Ung. & Kotschy
Brachythecium petrophilum Williams
Brachythecium suberythrorrhizon Ren. & Card.
Brachythecium suberythrorrhizon Renault & Card.
Brachythecium suberythrorrhizon var. *suberythrorrhizon* (Ren. & Card.) Grout
Brachythecium velutinum var. *venustum* (De Not.) Archangelico
Chamberlainia collina var. *suberythrorrhiza* (Ren. & Card.) Robins.
Hypnum venustum De Not.

Wyoming (FNA Vol. 28, 2014). (As *Brachythecium suberythrorrhizon* Ren. & Card.) Wyoming, Flowers (1973).

(As *Brachythecium velutinum* var. *venustum*) Albany Co.: Medicine Bow Mtns., Barber Lake picnic area, ca. 2.5 mi due NW of Centennial; ca. 8,700 ft, *Pinus contorta* forest along Libby Creek, 7 Jun 1993, *Reese 18169* (LAF); Laramie Mountains, Roger Canyon, 8 air mi NE of Laramie city center, 7850–8000 ft, on soil under shrubs, 7 Jun 1993,. *Miller 10,243* (NYS). Fremont Co. near border with Teton Co., between Moran and Dubois twps., on US 26, E of Togwotee pass, ca. 9,000 ft, at 63.0 mi; S-facing; spruce and 2 & 5-needle pines; herbaceous, not species abundant slope; *Artemisia tridentata* here and there; on granite; with *Dicranoweisia crispula,* 6 Jul 1985, *Eckel s.n.*. (BUF). Lincoln Co.: on granite boulder on slope above Salt River, Silver Stream Motel, 6000 ft, 11 mi N of Ashton, 11 Aug 1962, *Hermann 17843* (verified by Robinson as *Chamberlainia collina* var. *suberythrorrhiza*—seems to intergrade between *B. venustum* and *B. collinum* as noted by Weber and so noted by others) (RM). Teton Co.: on US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000', *Picea-Pinus flexilis* wood-land, xeric but for stream bottoms. *Lupinulus,* Asters, soil, forest floor, over organic debris, including punky wood, 6 Jul 1985, *Eckel 94081608*, c.fr. (RM, BUF).

Another specimen (*Eckel 94082003,* BUF) from the same locality shows a nearly complete intergradation with *Brachythecium collinum*. In the Teton specimen, many of the stems are light yellow green. Note the leaf cells are so thick walled and short that they appear to be those of an *Amblystegium*, were it not for the capsules. The serrations are as distinctive as in those of *B. collinum*, which may be a variant of this species (Weber 1973), much as *Brachythecium turgidum* seems to be a variant of *Br. salebrosum*.

In Lawton's (1971) key, she reflects the variability of the species in the degree of its plications (distinct to smooth) and the variability of the falcations (curved to straight)—the autoicous condition of this species is readily evident and critical to a quick determination of this plant. It is likely that Flower's (1973) *Brachythecium delicatulum, B. collinum* var. *idahense, B. collinum, B. velutinum* and *B. velutinum* var. *venustum* are all the same thing. The Reese specimen from Albany Co. was large and looked like *B. albicans* with its long, narrow acumina, but it was so falcate as to appear to be a *Drepanocladus;* it was autoicous, seta smooth and cells on margins serrulate, serrate in branch leaves, strongly plicate. Specimens of var. *salicinum* examined had smooth setae near the capsule and throughout and most of the leaves were straight (some somewhat curved). Specimens examined were strongly serrulate to the base. In many manuals *Brachythecium velutinum* is described as having a seta papillose throughout—this character would corresond to *Brachytheciastrum velutinum* var. *velutinum*, not yet noted for Wyoming.

BRACHYTHECIUM Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 5, plates 535–555. 1853. (Brachytheciaceae)

When taking leaves off a stem in *Brachythecium*, care must be made to preserve or note decurrencies (in many spp.: *B. frigidum, B. albicans, B. rutabulum, B. reflexum*, etc.). Alar cells are best seen in older leaves. Sometimes *B. salebrosum* can be so plicate it seems like a *Homalothecium*, that genus however is entirely dioicous. Quasi-deltoid, flat leaves with absolutely entire margins and inflated basal cells of plants from wet areas, such as the edges of lakes or in marshes may lead one to try *B. nelsonii* or *B. starkei* but one might also want to consider *Drepanocladus aduncus* var. *kneiffii*—this has straight leaves and may have them short—perhaps what one may not expect from a *Drepanocladus* (i.e., long, falcate leaves). The clue is the leaf cells which are short enough to remind one of the *Amblystegiaceae* and the completely entire leaf margins: of the two Brachythecia mentioned, the first has concave bases, the last is toothed and both have longer cells.

The sexual condition of Brachythecium is either autoicous or dioicous. That of *Sciuro-hypnum* is, as in *Brachytheciastrum*, autoicous (dioicous in *S. hylotapetum* and *S. latifolium*), although synoicous in *Brachytheciastrum fendleri*.

Note that the falcate types are:
B. leibergii (rough seta, autoicous, regularly pinnate, *smooth to serrulate,* esp. in branch leaves); large 1.8–2.6 mm. *Plicate.* The pinnate character is probably decisive; Lawton (1971: 293) says "The branching is usually more regularly pinnate than in any of the species which might be confused with it."

B. erythrorrhizon (smooth seta, irregular branching, dioicous, leaves 1.5–2 mm, branch leaves without spines at costa end). *Plicate.* Leaf margins *entire*. "Dioicous inflorescences and smooth setae, and the broad leaves are plicate and falcate with serrations at the tips" (Crum & Anderson 1981: 1032).

B. velutinum (smooth seta, irregular branching, autoicous, small: 1–1.8 mm leaves, costa with spines at tips, leaf margins). *Serrulate* (perhaps as in *B. collinum*, cf. Weber 1973), *not or slightly plicate*.

Brachythecium acutum (Mitt.) Sull., Icon. Musc., suppl., 99. 1874.
Hypnum acutum Mitt., J. Linn. Soc., Bot. 8: 33, plate 6 (upper right). 1864.
Amblystegium riparium var. *serratum* Ren. & Card.
Brachythecium pseudocollinum Kindb.

Wyoming (FNA Vol. 28, 2014). Albany Co. (*Porter 559; 747; 753; 783*); Teton Co. (*Porter 1159* & *1163*), Porter (1934). (As *Brachythecium acutum*) Albany County, Carbon County and Teton County, Porter (1935). Albany, Carbon, Teton cos. Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Albany Co. (*Porter 536, 542*); Carbon Co. (*Porter 900*); Teton Co. (*Porter 1205, 1216; 1185a*); Yellowstone Natl Park (*Nelson 5812; Porter 1242, 1244*), Porter (1934). Reported for Albany and Teton Cos. by Porter (1937), Crum and Anderson (1981: 1055) exclude it from the Eastern North American flora. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Centennial Valley, 17 Aug 1895, *Nelson 1698,* c.fr. (RM).

Excluded from northeastern North America by Crum and Anderson (1981). "Grout recognized this species from a broad range across the continent, in the northern United States and

adjacent Canada, south in our area to New Jersey and Ohio. Robinson considered it to be merely an eplicate form of *Brachythecium salebrosum,*" p. 1055. The Nelson specimen keyed to *Br. salebrosum* in Lawton (1971), not *B. albicans*, which is dioicous.

Brachythecium albicans (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 23. 1853.
Hypnum albicans Hedw., Sp. Musc. Frond., 251. 1801.
Brachythecium albicans var. *occidentale* Ren. & Card.
Brachythecium beringianum Card. & Thériot
Brachythecium pseudoalbicans Kindb.
Brachythecium pseudoalbicans Kindb. in Macoun
Chamberlainia albicans (Hedw.) H. Robinson

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1542–45*), Roell (1893). Mammoth, Old Faithful, and Lake, Yellowstone Natl Park (*Smiley*), Porter (1935). Teton Co., Spence (1985).

Lincoln Co.: moist open willow flat along Fire Trail Creek at Greys River, 6400 ft, Salt River Range, 8 mi E of Alpine Junction, 30 Aug 1973, *Hermann 25588*); specimen with no teeth except some at tip—including branch leaves: strongly falcate, branches not all julaceous when dry (RM); base of a dead tree in open shade, Fishing Bridge, 10 Sep 1932 *Smiley 257* (det. as *B. glareosum*-dioicous).

Separated from *B. erythrorhizon (*which is falcate) by the entire margins of branch leaves. The leaf apices are strikingly long-filiform in Crum & Anderson Exsiccat 783, although only slenderly acuminate (Crum & Anderson 1981: 1025). Stem leaves are strongly plicate and have long rather broad decurrencies, concave at the base. The stems are terete to julaceous—imbricate when dry. In the exsiccat specimen the lax quadrate cells are collapsed under Hoyer's solution. Flowers (1973) and Lawton (1971) make the point that the leaves are *entire*. "Sometimes slightly serrate at the apex only" according to Crum and Anderson (1981). The branches appear to be *small*. Specimens of *B. salebrosum* may occasionally have long acuminations, so untypical, one would think, that *B. albicans* may come to mind. *Brachythecium salebrosum* will be autoicous and the plants will be plumose, that is, foliose rather than julaceous or ropey as in *B. albicans*. Very important are the serrations all up and down the stem leaves of *B. salebrosum*, more pronounced on branch leaves: these are absent in *B. albicans*.

Brachythecium asperrimum (Mitt.) Sull. = Brachythecium frigidum (Müll. Hal.) Besch.

Brachythecium brandegeei (Austin) H. Robinson, Bryologist 65: 125. 1963 (as brandegei).
Hypnum brandegeei Aust., Bot. Gaz. 3: 31. 1878 (as brandegei).
Cirriphyllum brandegeei (Austin) Grout

Wyoming; "Wet soil in mountain tundra, rock, wet cliffs; high elevations (3100–3900 m); Colo., Wyo." (Ignatov, FNA Vol. 28, 2014), Kosovich-Anderson & Ignatov (2010). Park Co.: *Brachythecium brandegeei* was reported growing with *Polytrichastrum sexangulare, Polytrichum juniperinum,* and *Sanionia nivalis,* Kosovich-Anderson & Weber (2011). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

An extremely rare species in North America, which is difficult to separate from *B. udum* (see below). *Brachythecium brandegeei* is mostly restricted to Colorado, with an additional station from Wyoming. According to Ignatov (2014), *Brachythecium brandegeei* is reported and described in

North America only by a personal communication by W. A. Weber for Colorado in Clear Creek, Park and Summit counties, and a collection by Kosovich-Anderson in Wyoming, Kosovich-Anderson & Ignatov (2010) according to Ignatov (2014). The species was not reported for Colorado by Weber and Wittmann (2007), although apparently all the material in North America since the species was described derived from that state (see discussion below).

Brachythecium udum, which is found in northern Europe, can with difficulty be separated morphologically from *B. brangegeei*, as the two species are distinct mostly as the result of a phylogenetic sequence analysis. Both species "have ovate leaves abruptly contracted to the acumen, broad laminal cells, subentire leaf margins, and both are apparently dioicous (male plants and sporophytes unknown)." The following characters may be used to separate them (Ignatov 2014):

B. brandegeei: plants intense green, small to medium sized; leaves not plicate; laminal cells often broad in distal leaf; alar cells quadrate, slightly wider than laminal cells, thin-walled, in a rather inconspicuous group.

B. udum: plants light or pale green or straw-colored, medium-sized to large; leaves plicate; laminal cells narrow distally, broad proximally; alar cells variable: similar in width to laminal cells to (often) conspicuously enlarged and forming a pellucid area in the leaf corners.

Harold Robinson (1962) noted that "as far as I am aware, (*B. brandegeei*) is represented only by the series of sterile original specimens at the New York Botanical Garden, collected in Colorado" and suggested *B. brandegeei* "could be a rather aquatic form of *B. cirrosum."* It is not distinct from *B. cirrosum* except for its "lax appearance but does not differ greatly in essential details. The limited material does not permit any definite conclusions." *Brachythecium brandegeei* in Robinson's key to the genus notes the "alar cells never inflated, often poorly differentiated; leaves complanate-foliate (not strongly concave), leaf apex usually abruptly acuminate (not acute), leaf areolation very lax, cells 6–8 um wide; leaves not strongly concave; acumen very short."

Brachythecium calcareum Kindb. = Brachythecium campestre (Müll. Hal.) Schimp. in P. Bruch and W.P. Schimper

[*Brachythecium campestre* (Müll. Hal.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 16. 1853, excluded]
Hypnum rutabulum var. *campestre* Müll. Hal., Syn. Musc. Frond. 2: 368. 1851.
Brachythecium calcareum Kindb.
Brachythecium leucoglaucum Müll. Hal. & Kindb.

Not reported for Wyoming in FNA; according to Ignatov, the distribution of the species is eastern North America (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

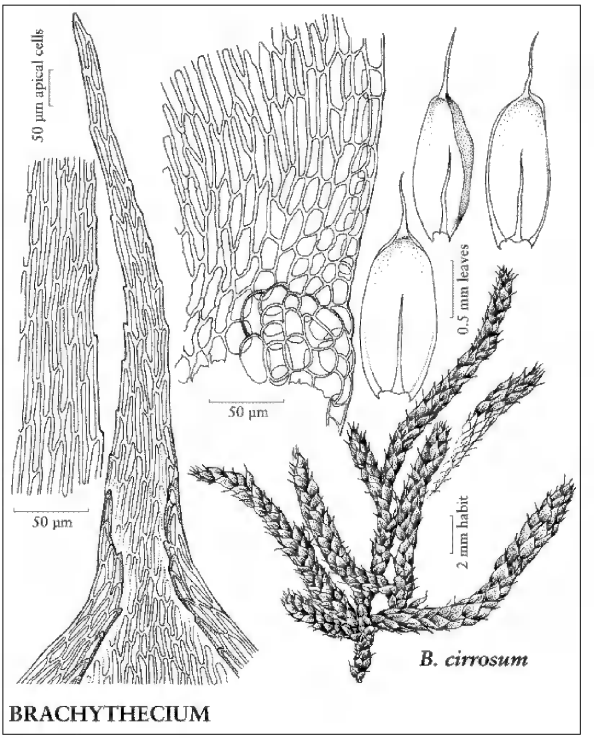
(As *Brachythecium calcareum*) (A specimen of Dwight C. *Smiley*'s at YELLO (no. 27) determined as *B. flexicaule*, "moist stream bank, mouth of Clematis Gulch" is a sterile, depauperate *Brachythecium*. A row of inflated basal cells attaching leaves to the stem seen on old leaves indicates this specimen is *Brachythecium frigidum.*

Brachythecium cirrosum (Schwägr.) Schimp., Syn. Musc. Eur., 696. 1860 (as cirrhosum).
Hypnum cirrosum Schwägr. in J.A. Schultes, Reise Glockner 2: 365. 1804.
Cirriphyllum cirrosum (Schwägr.) Grout

Wyoming (FNA Vol. 28, 2014).

(As *Cirriphyllum cirrosum*) Albany Co.: Medicine Bow Mts., Medicine Bow Natl Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, *Pinus contorta* forest along Libby Creek, 2660 m, *Buck 23189* (in specimen labeled *Amblystegium serpens*, with *Campylium hispidulum*, associated with rotten wood) (NY).

The margins are quite serrate, there are long decurrencies down the stem.



Courtesy FNA Association, FNA 28, 2014

Brachythecium collinum (Schleich. ex Müll. Hal.) Schimp. in B.S.G. = Brachytheciastrum collinum (Schleicher ex Müll. Hal.) Ignatov & Huttunen

Brachythecium leibergii Grout = Brachytheciastrum leibergii (Grout) Ignatov & Huttunen

Brachythecium erythrorrhizon Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 18, plate 547. 1853.

Var. **erythrorrhizon** or s.l.

Wyoming (FNA, Vol. 28, 2014). Albany, Carbon, Teton counties and Yellowstone Natl Park, Porter (1935). (?Albany (*Porter 859*); Carbon (*Porter 895*); Teton (*Porter 1217, 1222*; *Porter 1158, 1190*); Yellowstone Natl Park (*Smiley*), Porter 1934. Albany, Carbon, Teton Cos., Yellowstone

Natl Park, Porter (1937). Teton Co., Spence (1985), Ireland (1982). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co. "Growing along rotten log on moist soil, common," *Lichvar 1347a* (RM); carpeting floor of spruce forest, Little Brooklyn lake, 10,400 ft, Medicine Bow Mtns, 7 mi NW of Centennial, *Hermann 26721a.* (sterile, but leaves gently falcate in places on stem, plicate, entire margins, plicate, etc., rhizoids sparse (RM); Medicine Bow Mountains, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest; on soil under *Pinus contorta*, 7 Jun 1993, *Miller 10,257* (NYS). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Hwy, *Picea* forest with *Pinus flexilis* and *P. contorta*, *Vaccinium scoparium,* on forest floor, *Weber B–44219,* falcation strong, on wood (COLO, RM). Sublette Co.: Bridger Wilderness, Wind River Range 17 May 1989 ca. 1.5 mi E of Barnes Lake, 10,080 ft , 42°58' N, 109°34' W, thin peat terrace, *Andrus 7870* (BING). Teton Co.: Cascade Canyon, 14 Aug 1953, *Conard s.n* (US).

"Plants medium-sized to moderately large. Leaves falcate-secund, 1.5–2.3 mm; laminal cells linear, 60–90 \um" (Ignatov, FNA Vol. 28, 2014). This plant is said to have lots of rhizoids (abundant) at the base of the stem, but not seen in the last of the two specimens cited above or in any of the specimens seen. This species is yellow-green to pale yellow; green to sordid looking when the leaves assume a reddish cast, and then the red rhizoids evident. Sometimes the falcateness is only evident on some of the stems and stem Sect.s. The sterile Park Co. specimen is differentiated from *B. leibergii* by its irregular branching.

The leaves are unusually broad and falcate and deeply plicate, leaving one, macroscopically at least, to jump at it being *Drepanocladus uncinatus*. The costa appears very broad, hinting at *Cratoneuron*, but basal cells are not sharply inflated as in that genus (and *Palustriella*). The leaf cells appear short for a *Brachythecium*, hence an appearance of something in the Amblystegiaceae. The falcation and plication are striking under the dissecting scope. Note that *B. leibergii* is generally *serrate* along the leaf margins, or at the base (occasionaly smooth according to Lawton (1971). *Brachythecium erythrorrhizon* is more smooth, denticulate in the apex.

Var. **alpinum** Kosovich-Anderson & Ignatov, Arctoa 19: 190, fig. 4. 2011.

Wyoming, "Variety *alpinum* has strongly plicate and concave leaves, julaceous foliage, and numerous alar cells. These alpine plants from the Rocky Mountains resemble *Brachythecium coruscum* rather than *B. erythrorrhizon* var. *erythrorrhizon*, but differ in larger cells in alar regions and leaf decurrencies, Kosovich-Anderson and Ignatov (2010); Ignatov (FNA Vol. 28, 2014).

Brachythecium fendleri (Sull.) A. Jaeg. = Brachytheciastrum fendleri (Sull.) Ochyra & Żarnowiec

Brachythecium flexicaule Ren. & Card. = Brachythecium salebrosum (Hoffmann ex F. Weber & D. Mohr) Schimp. in P. Bruch and W.P. Schimper

Brachythecium frigidum (Müll. Hal.) Besch., Mém. Soc. Natl. Sci. Nat. Cherbourg 16: 248. 1872
Hypnum frigidum Müll. Hal., Bot. Zeitung (Berlin) 14: 456. 1856
Brachythecium asperrimum (Müll. Hal.) Sull.
Brachythecium lamprochryseum Müll. Hal. & Kindb. in Macoun
Brachythecium lamprochryseum var. *giganteum* Grout

Wyoming (FNA Vol. 28, 2014). (As *Brachythecium lamprochryseum* var. *solfaterense* Grout) Solfatara Creek, Yellowstone Natl Park (*Streeter*), "This is the type collections referred to by

Dr. Grout (1928)," Porter (1935). (As *Brachythecium lamprochryseum* Müll. Hal. & Kindb. in Macoun) Wyoming, Flowers (1973).

Albany Co.: Wood's Creek, Nelson 3480 (US); gregarious over moist bank, canyon bottom in pine forest, 8000 ft, Snowy Range, 31 Jul 1926, *Kelley 791* (NY); ca. 4 air mi E-SE of Centennial, NW base of Sheep Mountain along WY 11, 7700-7900 ft, *Populus, Betula* and *Salix* associated with spring seep, open fen, 7 Jun 1993, *Miller 10, 278* (NYS). Fremont Co.: peaty bank of stream on spruce-fir slope, Burroughs Creek Rd., 8400 ft, Absaroka Range, 14 mi N of Dubois, 28 Aug 1973, *Hermann 25511*, (NY, US); on branch submerged in stream on spruce-fir slope, Burroughs Creek Rd., 8400 ft, Absaroka Range, 14 mi N of Dubois, *Hermann 25520* (US); about 12 mi westward near Togwotee Pass, 9000 ft, on ground, 22 Jun 1931, *Frye s.n.* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, *Carex* fen S of Timico Lake, 18 May 1989, *Andrus 7891* (BING). Teton Co.: partially submerged in shallow stream along Hidden Falls Trail, NW of Jenny Lake, 7000 ft, Teton Range, Grand Teton Natl Park, *Hermann 25578* (US, RM). Yellowstone Natl Park: grassy seep, swale, roots of *Salix,* 6239 ft, a few mi from Mammoth Hot Springs on Road to Tower, with *Aulacomnium palustre, Amblystegium juratz., Bryoerythrophyllum recurvirostrum, Bryum pseudotriquetrum* var. *bimum, Distichium capillaceum, Drepanocladus aduncus* & *D. uncinatus, Leptobryum pyriforme, Plagiomnium rugicum, Plagiothecium denticulatum,* 6 Jul 1995, *Eckel 95082825* (BUF).

According to Flowers (1973) the leaves of both this and *Brachythecium asperrimum* can be "sometimes falcate" ! and so confused with *B. erythrorhizon*. In the Fremont Co. specimen, Frye 22 Jun 1931, the decurrent alar cells were distinctly inflated and enlarged. These inflations extended to the costa. For this species the stem attachment cells as left on the leaf are *shelved* so that you need to raise and lower the lens, a depth of field issue in one ridge that is very distinctive in this moss.

[*Brachythecium glareosum* (Br.) Bruch & Schimper, excluded]

Lake, Yellowstone Natl Park (*Smiley*), Porter (1935). Excluded from North America by Anderson et al. (1990). It is not included in the North American flora by Ignatov (FNA Vol. 28, 2014).)

Brachythecium laetum (Brid.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 24. 1853.
Hypnum laetum Brid., Bryol. Univ. 2: 479. 1827.
Brachythecium digastrum Müll. Hal. ex Kindb.

Wyoming (FNA Vol. 28, 2014). Wyoming; "the name *Brachythecium oxycladum* of American authors but not (Brid.) A. Jaeger has been applied to many species, which are *B. laetum"* (Ignatov FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1545*), Roell (1893).

Brachythecium leibergii Grout = Brachytheciastrum leibergii (Grout) Ignatov & Huttunen

Brachythecium nelsonii Grout = Sciuro-hypnum latifolium (Kindb.) Ignatov & Huttunen

Brachythecium oedipodium (Mitt.) A. Jaeg. = Sciuro-hypnum oedipodium (Mitt.) Ignatov & Huttunen

[*Brachythecium oxycladon* (Brid.) A. Jaeg., excluded from North America.]

Yellowstone Natl Park Mammoth and Canyon (*Smiley*), Porter (1935). Yellowstone Natl Park, Porter (1937). Also Porter (1934).

Brachythecium rivulare Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 17, plate 546. 1853.

Wyoming (FNA Vol. 28, 2014). Note *B. lamprochryseum* is not noted in the treatment of Brachytheciaceae by Ignatov (FNA Vol. 28, 2014). (As *Brachythecium lamprochryseum* var. *solfatarense* Grout. N. Am. Musci Pleuroc. *n. 327.* 1912 (in Lawton as 1910)). (As *Brachythecium lamprochryseum* var. *solfatarense*), Yellowstone Natl Park (*Mrs. Streeter*, type collection), Porter (1934). Wyoming: Yellowstone Natl Park (*1546),* Roell (1893). Albany Co. (*Porter 948, 1018*; *Nelson 5356; Porter 1030; Porter 662; Nelson 10951; Porter 781b*); Teton Co. *(Porter 1153, 1147, 1148*); Yellowstone Natl Park (*Smiley*), Porter (1934). Albany, Teton Cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985), citing Porter. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Peaty bank of N. Fork of Little Laramie River on Sand Lake Rd., 8500 ft, Medicine Bow Mts, 3 mi W Centennial, 4 Aug 1962, *Herman 17738*, sterile (NY); wet knoll on bank of Libby Creek, Libby Creek Campground, 8500 ft, Medicine Bow Mts., 2 mi W of Centennial, *Hermann 17674* (US); Medicine Bow Mtns, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, 2660 m, *Pinus contorta* forest along Libby Creek, *Buck 23198* (NY); Laramie, 15 Sep 1897, *Nelson 4283*, this specimen complanate, flat, leaves very distant on the stem and attenuated — a water form (RM, US). Crook Co.: Black Hills, ca. 6.5 km NNE of Warrens Peaks, along Beaver Creek, *Pinus ponderosa* on upper slopes and *Betula* along creek, moss partly shaded, wet ground in marsh, along creek, 44°32' N 104°25' W, 21 May 1977, *Churchill 8736* (MO). Fremont Co.: on wet boulder in stream on spruce-fir slope, Burroughs Creek Rd, 8400 ft, Absaroka Range, 14 mi N of Dubois, 28 Aug 1973 *Hermann 25517*, specimen broadly acuminate although flat above and with inflated cells to the costa (RM). Natrona Co.: Hat Six Falls, *Nelson 5037*, this specimen with distant leaves and sharply serrulate stem leaf margins; also det. Weber (RM). Park Co.: wet peaty edge of streamlet through tundra below Beartooth Pass, 10,000 ft, Shoshone Natl. Forest, 38 mi NW of Cody 19 Jul 1965, *Hermann 20075* (RM). Sheridan Co.: floating on water and on logs and branches in slow flowing water, Big Horn Natl Forest, T57N, R89W, Sect. 28, with *Mnium medium*, *McKee 92–049* (BUF, RM). Teton Co.: Hwy 22, Burbank Creek 6 mi SE of Victor, *Pinus-Pseudotsuga* forests, primitive rocks, 2260 m, on wet soil and rocks, 7 Aug 1981, *Duell & Duell 2230* (NY). Teton-Sublette cos.: Gros Ventre Mts., 8500 ft, *Curtis s.n.* (NY). Yellowstone Natl Park: Yellowstone Falls, 7500 ft, Jun-Aug 1897, *Rydberg & Bessey s.n.* (NY).

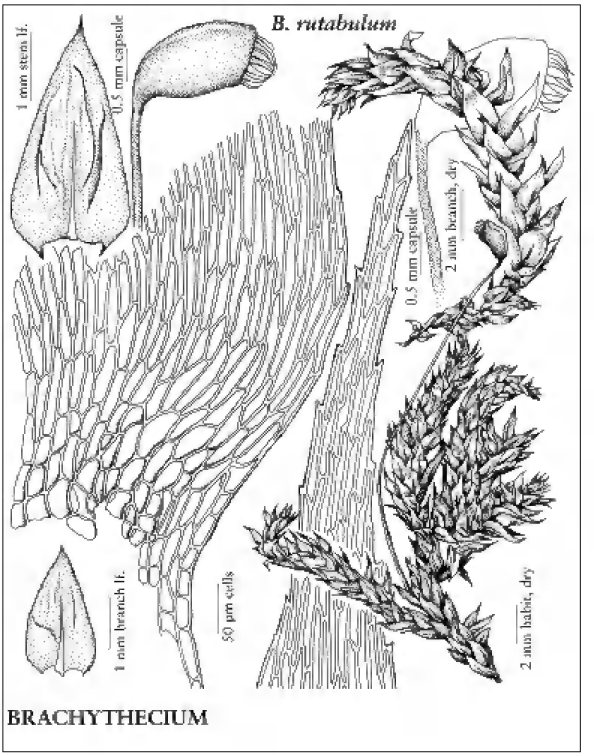
Floating on water and logs and branches in slow moving areas; in swampy areas and moist to soaked humus in forested areas, such as with *Picea glauca, Pinus contorta, P. ponderosa, Pseudotsuga*, in low, wetter areas along creeks and streams with *Salix* and *Betula* extending to from 3260 feet to tundra areas over 10,000 feet. These are robust plants that are pale white-yellow, or whitish green. Broad acute apices are striking for this species in the genus: sharply serrulate above, but some leaves smooth. It has a dendroid habit and leaves *strongly* concave like a spoon; cf. *B. nelsonii,* which is flat, has entire margins typical with extensive inflated basal cells reaching across to costa, and not a dendroid habit. The Hermann 25517 specimen resembled *B. nelsonii* in inflated cells to the costa and flat upper leaf, but the broadness of the leaf and its abrupt acumination made it *B. rivulare* (that is, the leaf shape was distinctive). Frequently occurring without a dendroid habit, apparently, and with leaves distant on stem—in water (submerged or emergent) forming "long loose masses or when crowded often becoming erect in deep dense tufts." Not *Scleropodium* because these are not or scarcely decurrent (Lawton 1971: 310).

Brachythecium rutabulum (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 15. 1853.

Hypnum rutabulum Hedw., Sp. Musc. Frond., 276. 1801.

Wyoming; "In eastern North America, *Brachythecium rutabulum* is widespread from the North Temperate Zone to the southern part of the Boreal Zone; in the West it has only been confirmed from British Columbia, Idaho, Montana, and Wyoming. Collections in Colorado were made at 1500–2740 m, otherwise *B. rutabulum* rarely exceeds 1000 m" (Ignatov, FNA Vol. 28, 2014). Big Horn Mts., Big Horn County (*Nelson 2234*), Porter (1935). Big Horn Co. (*Nelson 2234*), Porter (1934). Big Horn Co., Porter (1937).

Albany Co.: NW base of Sheep Mtn., along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula*, and *Salix*, 7 Jun 1993, *Buck 23247,* capsules missing, most setae detached and lost; note leaves plicate (NY).



Courtesy FNA Association, FNA 28, 2014

Almost identical to *Brachythecium leibergii* in every detail, this species is subpinnate, whereas *B. leibergii* is supposedly more pinnate. *Brachythecium leibergii* has falcate leaves, *B. rutabulum* straight;. *B. rutabulum* stem leaves are abruptly acuminate. Serrations are the same as are sexuality and rough setae. The specimen of *Buck 23247* has strongly plicate stem leaves; these are rather problematical, since this species is not or somewhat plicate. The branch ends also help differentiate the two species: in *B. leibergii* they are densely foliate, *B. rutabulum* they become distant on the stem, narrowed and hence "stoloniferous;" the stem is somewhat visible between leaf bases, as opposed to the dense crowding of the rest of the stem or branch.

Brachythecium rutabulum is said to be somewhat larger than *B. leibergii*. A specimen from Niagara Falls was nearly identical to the Wyoming material: serrate to base, subpinnate, abruptly narrowed acuminate, and *plicate*, concave; another was more oval, very sharply narrowed to a narrow acumen, hair-like and twisted: margins nearly smooth, yet in all other respects the same.

[*Brachythecium salebrosum* (Hoffmann ex F. Weber & D. Mohr) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 20. 1853, excluded]
Hypnum salebrosum Hoffmann ex F. Weber & D. Mohr, Bot. Taschenbuch, 312. 1807.
Brachythecium flexicaule Ren. & Card.
Brachythecium laevisetum Kindb. in Macoun

Not reported for Wyoming by FNA. "*Brachythecium salebrosum* was considered widespread in North America, but a revision of herbarium collections from eastern North America demonstrated mostly *B. acutum*, *B. campestre*, *B. rotaeanum*, and marginal phenotypes of *B. laetum* among these. However, plants of *B. salebrosum* that are identical with European plants occur in western North America and, probably, in eastern Canada" (Ignatov, FNA Vol. 28, 2014). All of the following specimens would need to be reviewed to the species as presented in FNA Vol. 28, 2014); but its presence is to be anticipated. (As *B. flexicaule*) Yellowstone, Porter (1937). (As *B. flexicaule*) Mammoth, Yellowstone Natl Park (*Smiley*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Lincoln Co.: on rotted wood on bank of Porcupine Creek on spruce-fir slope, Greys River Valley, 6600 ft, Salt River Range 18 mi SE Alpine Junction, 30 Aug 1973, *Hermann 25595,* capsules gone but setae abundant (US, RM). Park Co.: wet soil in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1743* (BUF). Sublette Co.: Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, wooded spruce bank, sandstone rocks, lush herbage, N slope, Hoback River valley, shaded sandstone rock, 5 Jul 1985, *Eckel 9612515* with *Drepanocladus uncinatus, Leptodictyum humile, Eurhynchiastrum pulchellum, Platydictya jungermannioides* (BUF, RM). Teton Co.: on US 26 & US 237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus, Asters,* wooded stream, soggy debris, c.fr., c. *Distichium capillacium, Aulacomnium palustre*, 6 Jul 1985, *Eckel 94082102* (BUF); dry humus in spruce-fir woods, Hidden Falls Trail NW of Jenny Lake, 7000 ft, 29 Aug 1973, *Hermann 25547* with young sporphyte (RM). Yellowstone Natl Park: on the moist ground in the timber, The Thunderer, 13 Jul 1899, *Nelson & Nelson 5812* (RM, US); Lost Lake outlet, 1 Sep 1948, *Conard 48–225* (det. as *B. glareosum*-autoicous) (YELLO); Clematis Gulch Trail, 16 Aug 1953, *Lawton 1801* (det. as *B. glareosum*-autoicous) (YELLO).

This species is robust, has densely foliose, turgid branches, and is much branched, straw colored: yellow/yellow-brown. In the Teton Co. (PME) specimen, the stems were a bright red-burgundy and the fruiting female buds kept popping off. There were no serrations at all on either stem or branch leaves. On the Hermann specimen from Teton, the margins were strongly serrate at the tip, the costa toothed, both margins recurved to apex, the leaf canaliculate. Lawton (1971) and Crum and Anderson (1981) do not describe the leaf this way—but Flowers (1973) does. Flowers may have had a big problem with the genus (note his treatment of *Brachythecium oxycladon, digastrum* and *campestre*). Also, a specimen from Sublette Co. had striking, long filiform acuminations, such as *B. albicans* has. Flowers again illustrates an acuminate apex for *B. salebrosum*, otherwise it would be hard to believe the Sublette specimen is indeed that. All leaves, stem and branch, were serrulate, the sex was autoicous and the apex was channeled with revolute borders. There does not seem to be anything else in the key that this specimen could be. Some leaves had decurrencies and excavate enlarged alar cells. Sometimes *B. salebrosum* can be so plicate it seems like a *Homalothecium*, however, that genus is all dioicous.

Brachythecium starkei (Brid.) Schimp. in B.S.G. = Sciuro-hypnum starkei (Brid.) Ignatov & Huttunen

Brachythecium turgidum (Hartman) Kindb., Vidensk. Meddel. Naturhist. Foren. Kjøbenhavn, ser. 4, 9: 294. 1888
Hypnum salebrosum var. *turgidum* Hartman, Handb. Skand. Fl. ed. 3, 2: 309. 1838

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: NW base of Sheep Mtn. along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula* and *Salix*, *Buck 23232* (NY). Park Co.: snowbeds, 3200 m, *Weber B–44306*, leaves short, dense on stem, to julaceous (COLO, RM, US).

Crum and Anderson (1981) suggest this may be only an ecological expression of *B. salebrosum*. Tufted habit means the branches are short and hence the leaves crowded, making short fat branches of a bright shiny golden to lemon yellow plant with brown along the lower leaves and stems. They stand up at you in tight bristly julaceous branches as you look down on them, wetted up, in the packet, under the dissecting microscope. The Weber specimen shows longer branches, but distinctly julaceous: the bright lemon or straw yellow with brown older parts of *B. salebrosum*. Both have the alar thick-walled pellucid cell groups.

Brachythecium udum I. Hagen, Kongl. Norske Vidensk. Selsk. Skr. (Trondheim) 1908(3): 4, plate 1, fig. 1. 1908.
Brachythecium mildeanum var. *udum* (I. Hagen) Mönk.
B. salebrosum subsp. *udum* (I. Hagen) J.J. Amann

Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Rocky Mountains, Shoshone Natl Forest, Beartooth Plateau, Beartooth Scenic Pass (Hwy 212), 45°01'N 109°25'W, dry course of creek in alpine tundra, not abundant, 10,100 ft, 13 Aug 2008, *Kosovich-Anderson 2493,* det. Ignatov 2010 (MO); Shoshone Natl Forest, Beartooth Plateau, Beartooth Scenic Pass (Hwy 212), 44°59'N, 109°25'W, vertical wall of pool, on peaty soil, 10,400 ft, 19 Aug 2008, *Kosovich-Anderson 3270* det. Ignatov 2010 (MO).

To be looked for on (seasonally) wet soil and soil-covered rocks in Arctic and alpine habitats in northern Canada and at higher elevations (over 3048 m = 10,000 ft.) in the Rocky Mountains. In Alaska the species grows at lower elevations (100 m = 328 ft). This species occurs in Siberia and northern Europe. In FNA Vol. 28, 2014, the only site for this species reported in North America was Alaska, based on W. C. Steere collections from No Luck Lake (Ignatov 2014). Its discovery along Highway 212 in Wyoming in tundra areas indicates it is probably more widespread in North America in higher elevations in the Rocky Mountains, such as Colorado, and northern Canada, but the species is easily confused with other species of *Brachythecium*, such as *B. acutum, B. albicans*, *B. boreale* and *B. brandegeei* (Ignatov 2014).

The Colorado endemic (with a Wyoming station) *Brachythecium brandegeei* is most close morphologically with *B. udum*, which is separated by phylogenetic sequence analysis (see discussion of *B. brandegeei*). The sexuality of *B. udum* is apparently dioicous (no male plants or sporophytes are known), and the leaves have enlarged alar cells. Leaves are abruptly acuminate and are nearly entire on the margins.

Brachythecium boreale (leaves acuminate with enlarged alar cells) has regularly serrulate leaf margins with small, sharp, and even teeth and is autoicous, and both species also found only in Alaska. *Brachythecium acutum* has "homogeneous areolation across the leaf base," the alar cells less differentiated than *B. udum*, which may have strongly enlarged alar cells in wet stations. *Brachythecium udum* also has "poor branching and commonly upright growth" (Ignatov 2014). *Brachythecium acutum* has triangular leaves and toothed margins, *B. udum* has ovate to ovate-lanceolate leaves an an entire margin.

Brachythecium velutinum (Hedw.) Schimp. = Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen var. velutinum

Brachythecium velutinum var. venustum (De Not.) Arc. = Brachytheciastrum velutinum var. salicinum (Schimper) Ochyra & Żarnowiec

[*Breutelia mohriana* (Müll. Hal.) Broth., excluded (Brachytheciaceae)]

Carbon Co., Porter (1937). Excluded from N American flora by Anderson et al. (1990). The genus is not reported for North America (Griffin, FNA Vol. 28, 2014).)

[*Brotherella recurvans* (Michaux) M. Fleischer, Nova Guinea 12: 120. 1914, excluded (Sematophyllaceae)]
Leskea recurvans Michaux, Fl. Bor.-Amer. 2: 311. 1803.

Not reported for Wyoming; a species with an eastern distribution (Schofield; FNA Vol. 28, 2014). Lincoln Gulch, Albany County (*Nelson 2628*). "The material is scanty, and Prof. Holz., who identified it, expressed a doubt as to the correctness of the determination," Porter (1935).

BRYOERYTHROPHYLLUM P.-C. Chen, Hedwigia 80: 4. 1941. (Pottiaceae)

Bryoerythrophyllum recurvirostrum (Hedw.) P.-C. Chen, Hedwigia 80: 5. 1941.
Weissia recurvirostra Hedw., Sp. Musc. Frond., 71. 1801.
Barbula aenea Müll. Hal. & Kindb. in Macoun
Barbula recurvirostra var. *latinervia* Holmen;
Barbula recurvirostris (Hedw.) Dix.
Bryoerythrophyllum recurvirostrum (Hedw.) Chen
Bryoerythrophyllum recurvirostrum var. *dentatum* (Schimper) H.A. Crum, Steere & L.E. Anderson
Bryoerythrophyllum recurvirostrum var. *latinervium* (Holmen) B.M. Murray;
Didymodon canadensis Kindb. in Macoun
Didymodon recurvirostris (Hedw.) Jenn.
Didymodon recurvirostrum var. *dentatus* (Schimper) Steere
Didymodon rubellus B.S.G
Didymodon rubellus var. *dentatus* Schimp.
Didymodon subruber Kindb.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest; widespread in the Middle West and in eastern North America, Greenland and Labrador to North Carolina. (As *Didymodon rubellus* (Hoffm.) B.S.G.) Pole Creek, Albany Co. (*Nelson 3438*), Yellowstone Canyon, Yellowstone Natl Park (*Smiley*), Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 10,000 ft, *Hermann 17145*; moist shaded soil at base of calcareous sandstone bluff, Roger Canyon, ca. 8000 ft, 10 mi NE of Laramie, 19 Aug 1961, *Hermann 171512 1/2*, (DUKE, RM). Big Horn Co.: Big Horn Mtns., large rock outcrop, 9200 ft, 9 Jul 1979, *Nelson 3332*, c.fr., old-calyptra, indehisced, (BUF, RM). Campbell Co.: SE Rochelle Hills, head of Wildcat and S. Fork Keyton Creeks, T 41 N, R 69 W, Sect. 11, 12, 1500–1550 m, natural brick and sandstone of Fort Union formation, *Pinus ponderosa-Juniperus*-sagebrush associations, on N slope, Jun 1975, *Weber 5–8* (det. as *Barbula unguiculata*) (COLO). Carbon Co.: 8500 ft, *Hermann 17190* (RM). Fremont Co.: Dubois, big spring about 4 mi E of Dubois, 23 Jun 1931, *Frye s.n.*, c.fr., (WTU); 8400 ft, *Hermann 25513* (RM). Park Co.: Lake Creek at Cody Road, W of Bear Tooth Butte, 24 Aug 1953, *Lawton 2093* (WTU). Sheridan Co.: moist limestone, Big Horn Mountains, T57N, R89W, Sect. 34, 16 Jun 1992, *McKee 92–007*, c.fr., indehisced (BUF, RM). Sublette Co.: 7950 ft, *Hermann 25341* (RM). Teton Co.: 7000 ft, *Hermann 25575* (RM); E of Teton Pass, 15 Aug 1953, *Lawton 1781* (WTU). Weston Co.: dryish hill, on ground, Newcastle, 16 Jul 1942, *Degener & Peiler s.n.*, c.fr., with *Desmatodon obtusifolius* (NY). Yellowstone Natl Park: Yellowstone Lake shoreline, limestone, 23 Jul 1980 *Zander & Eckel s.n.* (BUF); Crescent Hill, 17 Aug 1953, *Lawton 1843* (WTU).

BRYUM Hedw., Sp. Musc. Frond., 178, plate 42, figs. 8–12; plates 43, 44. 1801. (Bryaceae)

I find that there are four species that readily come to hand, all with long awns and appendiculate cilia. The sexuality and habit I have found useful in distinguishing them are these:

Bryum caespiticium (now *Gemmabryum caespiticium*): Stems short: central bulb "on the ground" with side shoots terminated by bulbs ("bulb" = rosulate but in a tear drop figure). *Dioicous*. Walls may be thin. There are no gametoecia at the tips of side branches (hence, sterile) as there almost always are in *B. pallescens*, the species with which this may be confused. The stems are not elongate, or if they are the rosulate leaf clump is subtended by reduced leaves distant on the stem, not foliose as in *B. pallescens*.

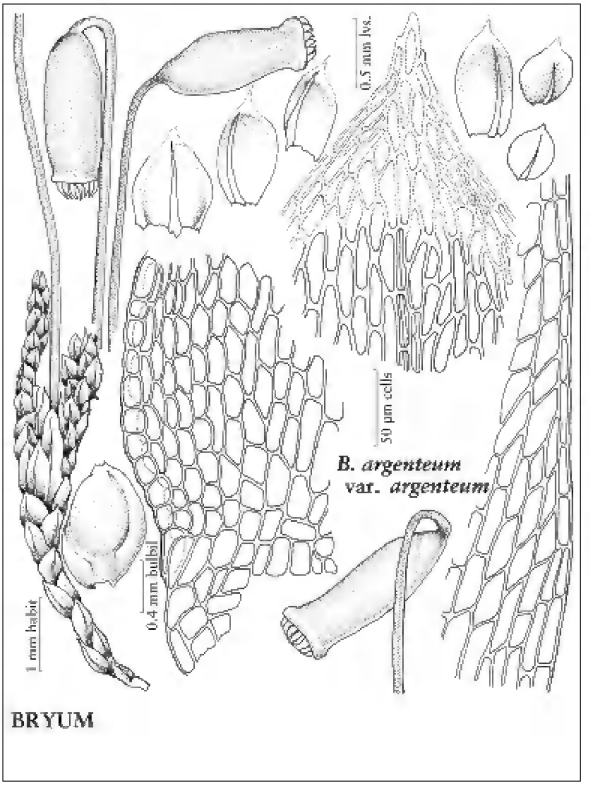
Bryum pallescens: Stems elongate, the leafy area elevated off the ground and leafy with numerous side branches: a "typical" looking plant. Dioicous (male stems). Cladautoicous: with antheridia on branches of fruiting stems, and frequently synoicous, that is, with a few antheridia amid the archegonia. (*B. algovicum* with its unique "gloppy" peristome (adherent endo and exostome, also is branched and *not rosulate*, with similar sexuality).

Bryum lisae var. *cuspidatum*: less diffusely branched, but apparently always synoicous. *Rosulate*. Note *B. pallescens* is not; *B. caespiticium* is, but is dioicous. *B. caespiticium* resembles bulbs but *B. lisae* seems to flare out like a cup: each stalk is ended in synoici (unlike *pallescens,* which is more often than not male). *Bryum pallescens* has actual branches attached to the stem with male things, and so are autoicous. *Rosulabryum capillare* has thin, lax cell walls, resembling *B. caespiticium*. Note it is only the fruiting stems that have long-awned leaves.

Bryum algovicum Sendtn. ex Müll. Hal. = Ptychostomum pendulum Hornschuch

Bryum alpinum Huds. ex With. = Imbribryum alpinum (Hudson ex Withering) N. Pedersen

Bryum amblyodon Müll. Hal. = Ptychostomum inclinatum (Sw. ex Brid.) J.R. Spence



Courtesy FNA Association, FNA 28, 2014

Bryum argenteum Hedw., Sp. Musc. Frond. 181. 1801.

Var. **argenteum**

Argyrobryum argenteum (Hedw.) Kindb.
Mnium lanatum P.-Beauv.
Plagiobryum argenteoides Williams

Wyoming (FNA Vol. 28, 2014). Cosmopolitan and common. Laramie, Albany Co. (Nelson 3454); Crow Creek, Albany County (*Porter 1446*), Porter (1935). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Laramie, *E. Nelson 3454* (RM); Laramie Plains, 2 air mi NE of Laramie center, Chugwater redbeds, rim of breaks, 7250–7300 ft, bare prairie soil between herbs, including *Astragalus, Eriogonum, Penstemon*, with *Tortula caninervis*, 7 Jun 1993, *Miller 10,250* (NYS). Sheridan Co.: Decaying conifer wood, Big Horn Mountains, T57N, R89W, 19 Jun 1992, *McKee 92-F6*, (RM).

Bryum argenteum Hedw. var. lanatum (P.-Beauv.) Hampe = Bryum lanatum (P.-Beauv.) Brid. (FNA Vol. 28, 2014)

Bryum bimum Schreb. ex Brid. = Ptychostomum bimum (Schreber) J.R. Spence

Bryum caespiticium Hedw. = Gemmabryum caespiticium (Hedw.) J.R. Spence

Bryum erythroloma (Kindb.) Syed = Rosulabryum erythroloma (Kindb.) J.R. Spence, a Pacific Coast species not likely to be found in Wyoming (Spence in FNA Vol. 28, 2014).

Bryum canariense Brid. = Rosulabryum canariense (Brid.) Ochyra in R. Ochyra et al.

Bryum capillare Hedw. = Rosulabryum capillare (Hedw.) J.R. Spence

Bryum creberrimum Taylor = Ptychostomum creberrimum (Taylor) J.R. Spence & H. P. Hamsay (FNA Vol. 28, 2014)

Bryum cyclophyllum (Schwaegr.) P. Bruch & Schimp. in B.S.G. = Ptychostomum cyclophyllum (Schwägr.) J.R. Spence

Bryum dichotomum Hedw. = Gemmabryum dichotomum (Hedw.) J.R. Spence

Bryum flaccidum Brid. = Rosulabryum flaccidum (Brid.) J.R. Spence, q.v.

Bryum gemmiparum DeNot. = Imbribryum gemmiparum (DeNot.) J.R. Spence

Bryum lanatum (P.-Beauv.) Brid., Muscol. Recent., suppl. 3: 20. 1817.
Mnium lanatum P.-Beauv., Prodr. Aethéogam., 75. 1805.
Bryum argenteum var. *lanatum* (P.-Beauv.) Hampe

Wyoming (FNA Vol. 28, 2014)

Bryum lisae var. cuspidatum (B.S.G.) Marg. = Ptychostomum creberrimum (Taylor) J.R. Spence & H.P. Ramsay (FNA Vol. 28, 2014)

[*Bryum occidentale* Sulliv., excluded (Bryaceae)]

The specimen listed as *Bryum occidentale* Sulliv. Bridger Peak, Carbon Co. (Goodding 1966) by Porter (1935) was seen to be *Bryum caespiticium* in both the specimen at RM and US. *Bryum occidentale* does not occur under the Bryaceae (FNA Vol. 28, 2014).

Bryum pallens (Brid.) Sw. in Roel. = Ptychostomum pallens (Sw.) J.R. Spence

Bryum pallescens Schleich. ex Schwägr. = Ptychostomum pallescens (Schleicher ex Schwägr.) J.R. Spence

Bryum pseudotriquetrum var. bimum (Schreb. ex Brid.) Lilj. = Ptychostomum bimum (Schreber) J.R. Spence

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb. = Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P. Ramsay ex Holyoak & N. Pedersen

Bryum sandbergii Holz. = Roellobryon roellii (Broth.) Ochyra

Bryum stenotrichum Müll. Hal. = Ptychostomum inclinatum (Sw. ex Brid.) J.R. Spence .

Bryum tortifolium Funck in Brid. = Ptychostomum cyclophyllum (Schwägr.) J.R. Spence

Bryum torquescens Bruch ex De Not. = Rosulabryum torquescens (Bruch ex De Not.) J.R. Spence, q.v.

Bryum turbinatum (Hedw.) Turn. = Ptychostomum turbinatum (Hedw.) J.R. Spence

Bryum uliginosum (Brid.) P. Bruch & Schimp. in B.S.G. = Ptychostomum cernuum (Hedw.) Hornschuch

Bryum weigelii Spreng. in Biehler = Ptychostomum weigelii (Sprengel) J.R. Spence,

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BUCKLANDIELLA Roivainen, Ann. Bot. Fenn. 9: 116. 1972. (Grimmiaceae)

Bucklandiella macounii (Kindb. in Macoun) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 146. 2003.
Racomitrium brevipes Kindb., Bull. Torrey Bot. Club 16: 93. 1889.
Racomitrium heterostichum var. *macounii* (Kindb.) G.N. Jones
Racomitrium robustifolium Kindb.

Only the subsp. *macounii* is reported for Wyoming (FNA Vol. 27, 2007).

[*Bucklandiella sudetica* (Funck) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 147. 2003, doubtful]
Trichostomum sudeticum Funck, Deutschl. Moose, 26. 1820.
Campylopus sudeticus (Funck) Fürnrohr.
Racomitrium heterostichum var. *sudeticum* (Funck) Dixon
Racomitrium jensenii Kindb.
Racomitrium sudeticum (Funck) P. Bruch & W.P. Schimper
Racomitrium sudeticum (unranked) *papillosum* C.E.O. Jensen
R. sudeticum var. *alaskanum* Card. & Thériot

The following reports (as *Racomitrium sudeticum* (Funck) P. Bruch & Schimp. in B.S.G.) are perhaps some other species, as *Bucklandiella sudetica* is not reported for Wyoming in FNA 2007. (As *Racomitrium sudeticum*) Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Racomitrium sudeticum*) PARK CO.: Beartooth Plateau, Cooke City to Red Lodge Highway; swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m; over irrigated rocks, small cascades between lakes 19 Aug 1973, *Weber B–44279* (COLO, WTU). This specimen approached fo. *brevipes* (Kindb.) Lawt. See discussion in Crum and Anderson (1981: 450) sub *R. heterostichum* var. *microcarpon*.

BUXBAUMIA Hedw., Sp. Mlusc. Frond. 166. 1801. (Buxbaumiaceae)

Buxbaumia aphylla Hedw., Sp. Musc. Frond., 166. 1801.

No species of the genus *Buxbaumi*a was reported for Wyoming (FNA Vol. 27, 2007).

Yellowstone Lake, Yellowstone Natl Park, collected by Conard. No specimen seen, Porter (1935).

Yellowstone Natl Park (Park Co.): ca. 7 mi from Canyon Lodge on road to Norris, 29 Aug 1951, *Lawton, 1505,* c.fr. (WTU).

Buxbaumia viridis (DC.) DC. in J.B. Mougeot et al., Stirp. Crypt. Vogeso-Rhen. 8: 724. 1823.
Buxbaumia aphylla var. *viridis* DC. in J. Lamarck and A.P. de Candolle, Fl. Franç. ed. 3, 6: 227. 1815.
Buxbaumia indusiata Brid.

Found in all states of the Pacific Northwest, but not common. Teton Co., Spence (1985).

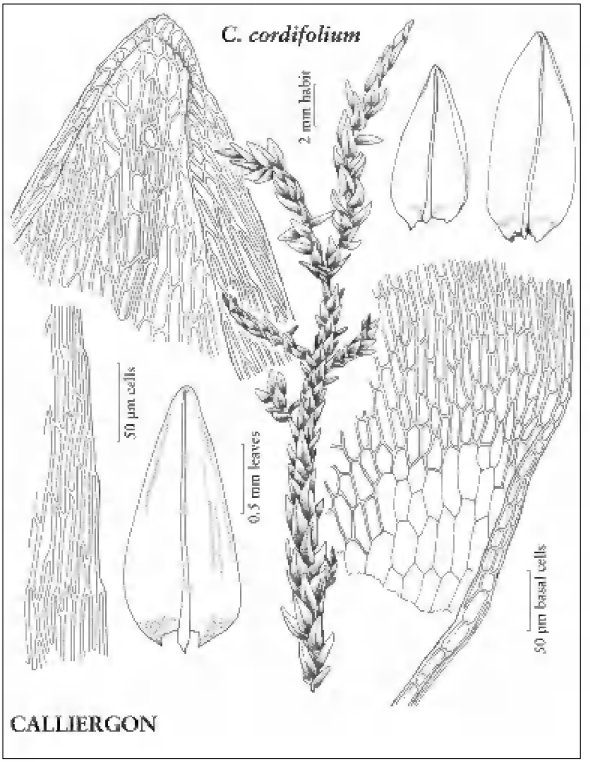
Lincoln Co.: on well-rotted log in partial clearing on spruce-fir slope along Porcupine Creek, Greys River Valley, Salt River Range, 18 mi SE Alpine Junction, 6600 ft, 30 Aug 1973, *Hermann 25593*, c.fr. (WTU).

CALLIERGON (Sull.) Kindb., Canad. Rec. Sci. 6: 72. 1894. (Calliergonaceae)

Calliergon cordifolium (Hedw.) Kindb., Canad. Rec. Sci. 6: 72. 1894.
Hypnum cordifolium Hedw., Sp. Musc. Frond., 254. 1801.
Calliergon cordifolium (Hedw.) Kindb.
Calliergon cordifolium fo. *intermedium* Grout

Not reported for Wyoming (FNA); "*Calliergon cordifolium* is most frequently confused with the dioicous c. *giganteum* when the latter species does not form its characteristic miniature sprucelike shoots" (Hedenäs, FNA Vol. 28, 2014). Yellowstone Lake, Yellowstone Natl Park (*Smiley*); Carbon County (*Porter 1694*), Porter (1935). Carbon Co., Yellowstone Natl Park, Porter (1937). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: wet soil in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1778* (BUF). Carbon Co.: Stampmill Lake, with *Sphagnum* in an alpine bog mat, 10,000 ft, *Porter 2084* (TENN); near Silver Lake, mixed with *Sphagnum* in a floating mat in a bog, 10,000 ft, *Porter 1694* (TENN).

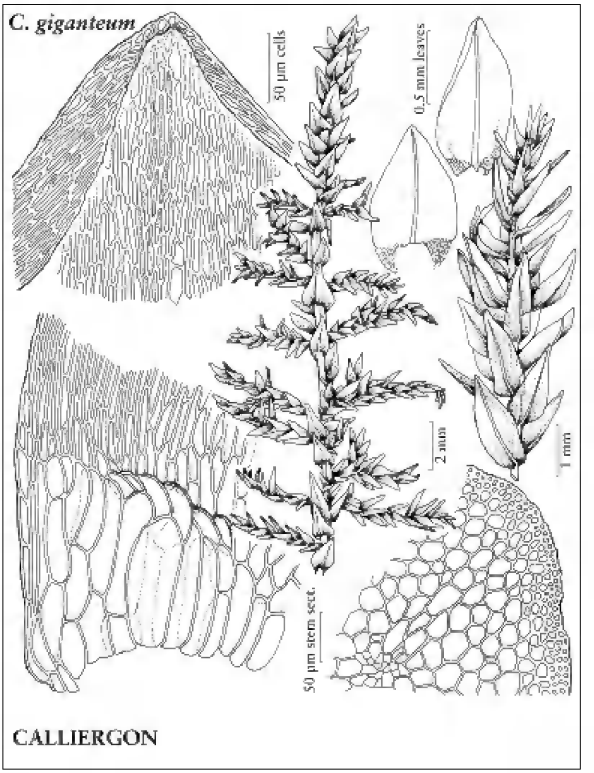


Courtesy FNA Association, FNA 28, 2014

Calliergon giganteum (Schimper) Kindb., Canad. Rec. Sci. 6: 72. 1894.
Hypnum giganteum Schimper, Syn. Musc. Eur., 642. 1860.
Calliergon subsarmentosum Kindb.
Hypnum cyclophyllotum Holz.

Wyoming: "Plants of *Calliergon giganteum* frequently resemble miniature spruce trees because of dense and successively longer branches from the shoot apex downwards, regular radial branching, and somewhat spreading branch leaves" (Hedenäs, FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

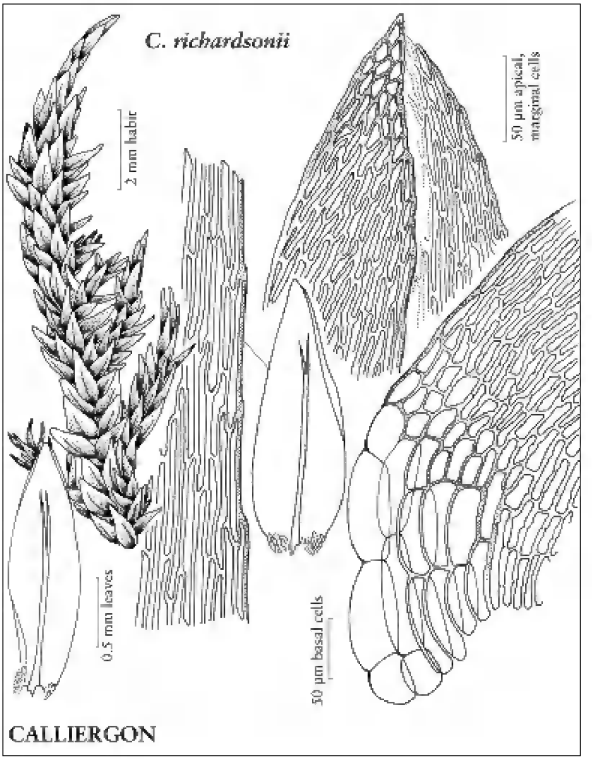
Albany Co.: 8500 ft, *Hermann 25607* (RM), same locale, 9700 ft, *Sturges 251* (RM); NW base of Sheep Mtn. along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula,* and *Salix*, *Buck 23240* (NY); ca. 4 air mi ESE of Centennial, NW base of Sheep Mountain along WY 11, 7700–7900 ft, *Populus, Betula*, and *Salix*, associated with spring seep, open fen, 7 Jun 1993, *Miller 10, 274* (NYS).



Courtesy FNA Association, FNA 28, 2014

Calliergon richardsonii (Mitt.) Kindb., Eur. N. Amer. Bryin. 1: 80. 1897 (as richardsoni).
Stereodon richardsonii Mitt., J. Linn. Soc., Bot. 8: 42. 1864 (as richardsoni).
Calliergon macounii Karczmarz
Calliergon obtusifolium Karczmarz
Calliergon subgiganteum Kindb.
Hypnum richardsonii (Mitt.) Lesq. & James

Wyoming; "*Calliergon richardsonii* is easily separated from other members of *Calliergon* by its comparatively short, usually branched or 2-fid stem leaf costa" (Hedenäs, FNA Vol. 28, 2014). Wyoming: Lawton (1971). Crum and Anderson (1981: 1003) mention a report from Wyoming but did not see a specimen. Johnson Co., reported by Lenz (2006) in association with *Warnstorfia tundrae*. Perhaps they are referring to Lawton's citation. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Calliergon sarmentosum (Wahlenb.) Kindb. = Sarmenthypnum sarmentosum (Wahlenberg) Tuomikoski & T. Koponen

Calliergon stramineum (Brid.) Kindb. = Straminergon stramineum (Dickson ex Brid.) Hedenäs

Calliergon trifarium (F. Weber & D. Mohr) Kindb. = Pseudocalliergon trifarium (F. Weber & D. Mohr) Loeske

Calliergon turgescens (T. Jens.) Kindb. = Pseudocalliergon turgescens (T. Jens.) Loeske

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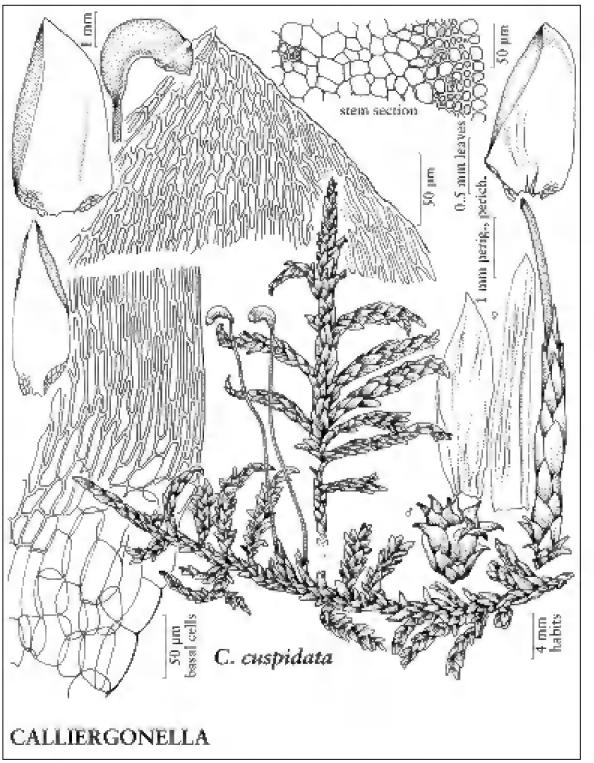
CALLIERGONELLA Loeske, Hedwigia 50: 248. 1911. (Amblystegiaceae)

Calliergonella cuspidata (Hedw.) Loeske, Hedwigia 50: 248. 1911.
Hypnum cuspidatum Hedw., Sp. Musc. Frond., 254. 1801.
Acrocladium cuspidatum (Hedw.) Lindb.
Calliergon cuspidatum (Hedw.) Kindb.
Calliergon cuspidatum (Hedw.) Kindb.
Calliergonella conardii Lawt.

Wyoming (FNA Vol. 28, 2014). (As *Hypnum cuspidatum*) Wyoming: Yellowstone Natl Park (*1579*), Roell (1893). Ireland 1982. Sublette Co., Cooper & Andrus (1994).

Park Co.: (with *Hygrohypnum styriacum* specimen, q.v.): Beartooth Lake, W and SW shore, *Picea engelmannii* forest along the shore, on wet clay, assoc. with *Sanionia uncinata, Calliergonella cuspidata*, T57N R105W S6&7, 44°56.500–520' N, 109°35.980–990' W, ca. 8900 ft (2700 m), 24 Jul 2010, *Kosovich-Anderson 6652* (no herb. cited). Yellowstone Natl Park: Lost Lake, 17 Aug 1953, *Lawton 1821* (isotype, WTU); with *Dichelyma uncinata*, Lost Lake near Roosevelt Lodge, 28 Aug 1951, *Lawton 1495* (WTU); 9 mi S of Madison Junction, 29 Aug 1951, *Lawton 1512* (WTU). Yellowstone Natl Park: Black Sand Basin, 18 Aug 1953, *Lawton 1866* (WTU).

This species may be confused with *Hygrohypnum ochraceum* in its softer, non calcium-encrusted forms, but that species may be distinguished by the much longer forked costa extending to the leaf middle and somewhat beyond, whereas *C. cuspidata's* costae are short.



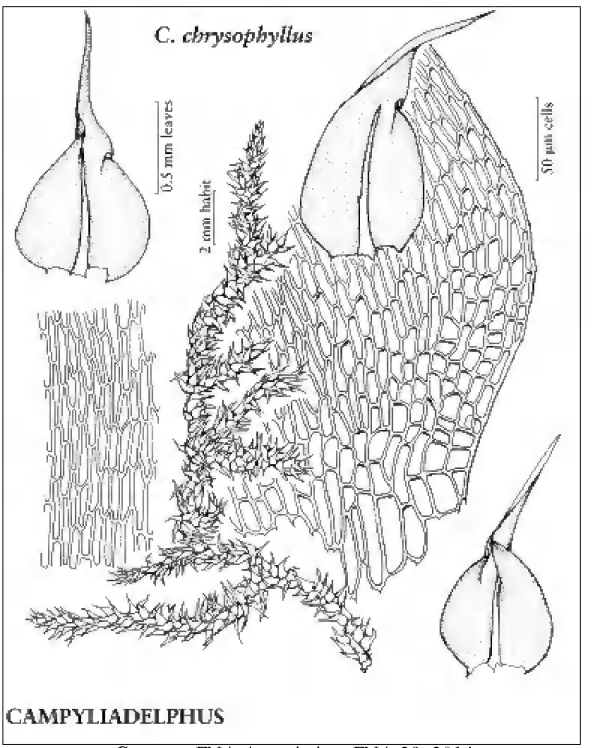
Courtesy FNA Association, FNA 28, 2014

[*Camptothecium lutescens* (Hedw.) Schimp. in B.S.G. = Homalothecium lutescens (Hedw.) Robinson, q.v. Excluded from North America (1990 checklist and FNA Vol. 28, 2014).]

CAMPYLIADELPHUS (Kindb.) R.S. Chopra, Taxon. Indian Mosses, 442. 1975. (Amblystegiaceae)

Campyliadelphus chrysophyllus (Brid.) Kanda, J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 15: 264. 1976.
Hypnum chrysophyllum Brid., Muscol. Recent. 2(2): 84, plate 2, fig. 2. 1801.
Campylium chrysophyllum (Brid.) Lange
Campylium chrysophyllum var. *brevifolium* (Ren. & Card.) Grout
Hypnum chrysophyllum var. *brevifolium* Ren. & Card.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

(All as *Campylium chrysophyllum*) Albany Co.: 8500 ft, *Hermann 17773* (RM); ca. 4 air mi ESE of Centennial, NW base of Sheep Mountain along WY 11, 7700–7900 ft, *Populus, Betula*, and *Salix* associated with spring seep, fen area, on soil bank, 7 Jun 1993, *Miller 10,277,* with *Leptobryum pyriforme* and *Hennediella heimii* (NYS). Natrona Co.: S of I-25, take Center St. to Wolcott St. to Casper Mtn. Drive WY 252, Rotary Club Park in N-slope foothills, wooded creek ravine, *Salix, Ribes, Alnus,* granite rocks, with *Cratoneuron filicinum,* 7 Jul 1985, *Eckel 94100400* (BUF). Sweetwater Co.: ca. 6400 ft, on US (187)191 at 14-Mile Reservoir picnic area, US Dept. Interior, wet

wooden bridge over brooklet, shaded ravine in *Artemisia* scrubland, with *Hennediella heimii*, 5 Jul 1985, *Eckel 212086* (BUF). Teton Co.: on US 26 & US 237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus,* asters, wooded stream, soggy debris, with *Drepanocladus aduncus, Distichium capillaceum, Aulacomnium palustre, Brachythecium salebrosum, Cratoneuron filicinum*, 6 Jul 1985, *Eckel 94082108* (BUF). Weston Co.: Beaver Creek, *Nelson 2563* (RM).

CAMPYLIUM (Sull.) Mitt., J. Linn. Soc., Bot. 12: 631. 1869. (Amblystegiaceae)
Hypnum sect. Campylium Sull. in A. Gray, Manual ed. 2, 677. 1856.

Species of *Campylium* seem to approach the appearance of *Conardia compacta* in the Amblystegiaceae—that species has long, almost vermicular leaf cells rather than the boxy cells of the Amblystegiaceae generally. That species also has a longer costa than in any species of *Campylium,* which goes to the leaf middle or somewhat above. Also *C. compacta* has distinctive irregular serrations at the basal margins.

Campylium chrysophyllum (Brid.) J. Lange = Campyliadelphus chrysophyllus (Brid.) Kanda

Campylium hispidulum (Brid.) Mitt. = Campylophyllum hispidulum (Brid.) Hedenäs

Campylium polygamum (Schimp. in B.S.G.) C. Jens. = Drepanocladus polygamus (Schimper) Hedenäs

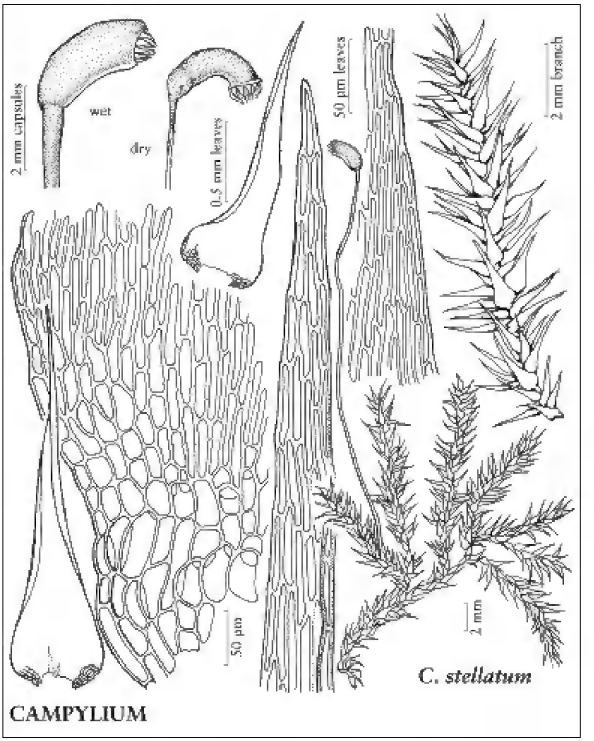
Campylium protensum (Brid.) Kindb., Canad. Rec. Sci. 6: 72. 1894.
Hypnum protensum Brid., Muscol. Recent. 2(2): 85, plate 2, fig. 3. 1801.
Campyliadelphus protensus (Brid.) Kanda
Campylium stellatum var. *protensum* (Brid.) Bryhn

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Campylium stellatum (Hedw.) C.E.O. Jensen, Meddel. Grønland 3: 328. 1887.
Hypnum stellatum Hedw., Sp. Musc. Frond., 280. 1801.
Campyliadelphus stellatus (Hedw.) Kanda

Wyoming (FNA Vol. 28, 2014). Beaver Creek, Weston County, (*Nelson 2556*), Porter (1935). Weston Co., Porter (1937). Sublette Co., Cooper & Andrus (1994). Johnson Co., in association with *Warnstorfia tundrae,* Lenz 2006). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: peaty vertical bank of streamlet in mtn. meadow, 1 1/4 mi S of Brooklyn Lake, 10,000 ft, Medicine Bow Mts, 9 mi W of Centennial, *Hermann 17679 1/2* (RM). Carbon Co.: wet, rocky edge of Trail Creek, W of Sand Lake Rd, 9000 ft, Medicine Bow Mountains, 4 1/2 mi SW of Morgan, *Hermann 17807* (RM). Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1716* (BUF). Sublette Co.: Bridger Wilderness, Wind River Range 14 May 1989, Barnes Lake, 42°57'30" N, 109°36' W, mineralized seeps at S end of lake, 9747 ft, *Andrus 7786* (BING). Weston Co.: Beaver Creek, *Nelson 2556* (RM).



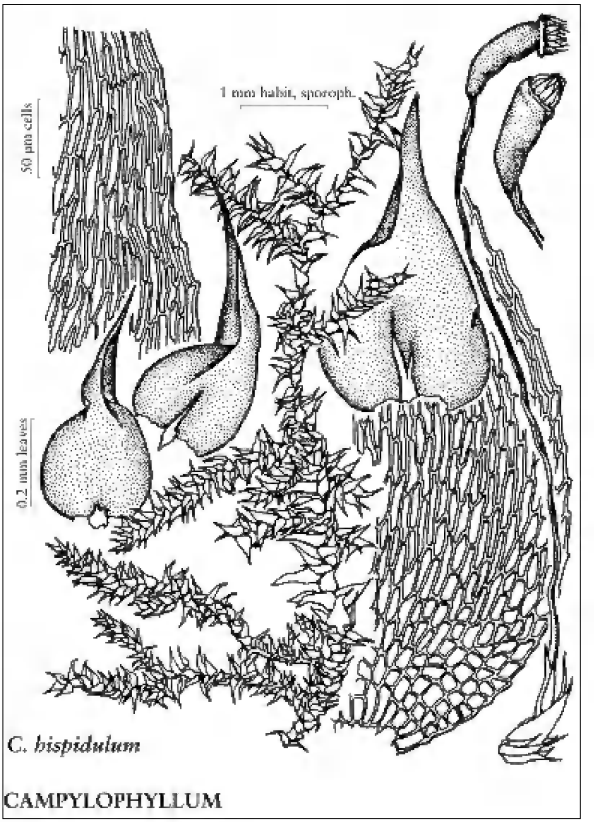
Courtesy FNA Association, FNA 28, 2014

CAMPYLOPHYLLUM (Schimper) m Fleischer, Nova Guinea 12: 123. 1914. (Amblystegiaceae)
Hypnum subg. *Campylophyllum* Schimper, Syn. Musc. Eur. ed. 2, 721. 1876.

Campylophyllum hispidulum (Brid.) Hedenäs, Bryologist 100: 74. 1997.
Hypnum hispidulum Brid., Muscol. Recent., suppl. 2: 198. 1812.
Campylium hispidulum (Brid.) Mitt.
Campylium hispidulum var. *cordatum* Grout

Not reported for Wyoming in FNA (FNA Vol. 28, 2014). (As *Campylium hispidulum*) Cooper Hill, Albany County (Nelson 4296); Beaver Creek, Weston County (*Nelson 2563*), Porter (1935). Albany, Weston Cos., Porter (1937).

(As *Campylium hispidulum*) Albany Co.: Medicine Bow Mts., Medicine Bow Natl Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, *Pinus contorta* forest along Libby Creek, 2660 m, *Buck 23189*, in specimen labeled *Amblystegium serpens*, with *Brachythecium cirrosum*, associated with rotten wood (NY).



Courtesy FNA Association, FNA 28, 2014

CAMPYLOPUS Brid., Muscol. Recent., suppl. 4: 71. 1818. (Dicranaceae)

Campylopus fragilis (Brid.) P. Bruch & W.P. Schimper, Bryol. Europ. 1: 164. 1847.
Dicranum fragile Brid., J. Bot.(Schrader) 1800: 296. 1801.
Campylopus citrescens Stirt.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007, where it is noted only from British Columbia and "a single locality in Arkansas" (Frahm, FNA Vol. 27, 2007).

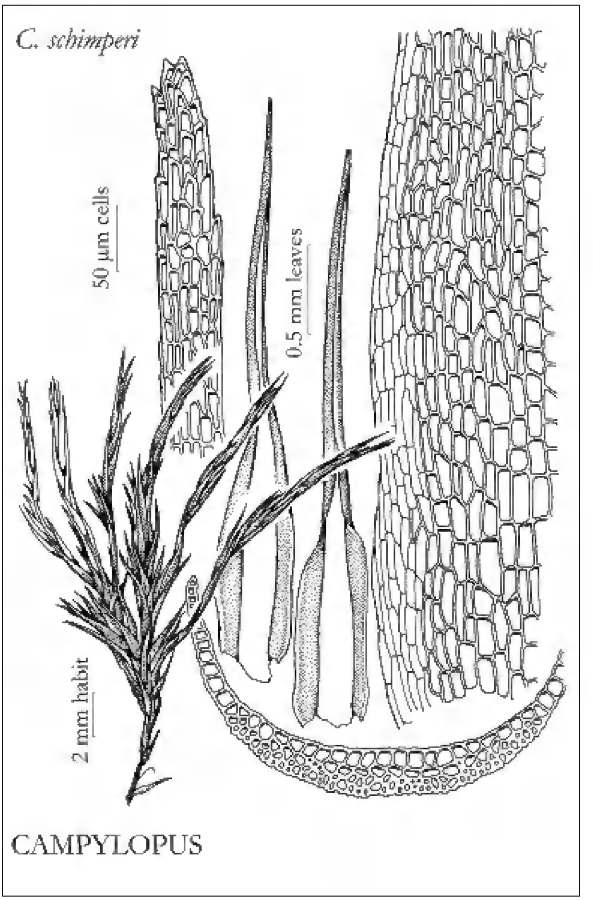
Yellowstone Natl Park: ca. 5 mi from Canyon Lodge, road to Norris, 29 Aug 1951, *Lawton 1498* (WTU).

This specimen is differentiated from the similar *Campylopus schimperi* Milde by the presence of stereid cells on the dorsal side of the costa in Sect., whereas the cells of c. *schimperi* are said to be too wide to qualify as stereids. *Campylopus schimperi* is smooth on the back of the costa (Crum & Anderson 1981), whereas C. *fragilis* has ridges (Smith 1978).

Campylopus schimperi Milde, Bot. Zeitung (Berlin) 22: 13. 1864.
Campylopus subulatus var. *schimperi* (Milde) Husnot

Not reported for Wyoming in FNA Vol. 27, 2007. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, Little Bear Lake vicinity, subalpine aapa mire fen crossed by US Hwy 212, in pure mats on saturated soil at base of low hummock around swale, T57N, R105W, S11, 4456.260–290' N, 10930.920–950' W, 2910 m, 16 Aug 2008, *Kosovich-Anderson 2896* (BONN, MO, RM), Kosovich-Anderson (2011a).



Courtesy FNA Association, FNA 28, 2014

Campylopus talluensis Sull. & Lesq., Musci Bor.-Amer. 73b [Schedae 17]. 1856 [1857].

Wyoming (FNA Vol. 27, 2007).

Yellowstone Natl Park: Heart Lake, hot water formation, *Streeter s.n.* (DUKE).

"*Campylopus tallulensis* occurs in southeastern North America in Virginia, North and South Carolina, Tennessee, Georgia, Arkansas, Alabama, Ohio and Louisiana with disjunct occurrences in the west in southern Arizona and Wyoming. It is also known from Mexico—where it is rather common, Bolivia and Colombia. This distribution pattern in southeastern United States, Mexico and northern South America, which is characteristic of other bryophytes and flowering plants, is considered indicative of Tertiary relictual status (Crum 1951 dissertation). Because of confusions with c. *flexuosus*, the total range of c. *tallulensis* is not yet sufficiently known" (Frahm 1980).

CERATODON Brid., Bryol. Univ. 1: 480. 1826. (Ditrichaceae)

Ceratodon purpureus (Hedw.) Brid., Bryol. Univ. 1:480. 1826.
Dicranum purpureum Hedw., Sp. Musc. Frond., 136, plate 36. 1801.
Ceratodon columbiae Kindb.
Ceratodon conicus (Hampe) Lindb.
Ceratodon purpurascens (Hedw.) Jennings
Ceratodon purpureus var. *purpurascens* (Hedw.) Brid.
Ceratodon purpureus var. *xanthopus* Sull.
Dicranum purpurascens Hedw.
Trichostomum conicum Hampe in Müll. Hal.

subsp. **purpureus**

Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park, 7000' (*1448*), Roell (1893). Yellowstone Canyon, Yellowstone Natl Park (*Smiley)*, Porter (1935). Common throughout most of the State; Albany County, Carbon, Crook, Johnson, Sheridan, Teton Counties and Yellowstone Natl Park, Porter (1935). "Common in front of glaciers", Teton Range, Grand Teton Natl Park, Wyoming, Spence (1981). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 8500 ft, 10,500 ft, *Lichvar 1339* (RM); *1328* (RM). Bighorn Co.: just off US 16 between TenSleep & Buffalo (near Sitting Bull Campsite), *Pinus contorta* var. *latifolia* being lumbered, just N of Washakie Co. border, ca. 5000 ft, disturbed soil, *Bryum lisae* var. *cuspidatum,* 6 Jul 1985, *Eckel 94092201* (BUF, RM). Carbon Co.: (in specimen of *Desmatodon latifolius*), rotted wood in soil in lodgepole pine woods along Trail Creek, Sand Lake Rd., 9000 ft, Medicine Bow Mts., 4.5 mi SW Morgan, *Hermann 17813* (WTU). Crook Co.: Devils Tower Natl. Monument, summit of Devils Tower, Jul 1990, *Fortney s.n.* (BUF, NY). Fremont Co.: 23 Jun 1931, *Frye s.n.* (RM). Park Co.: 6000 ft, 1 Apr 1988, *Vukelich s.n.* (BUF). Johnson Co.: Big Horn Mtns., along Middle Fork Crazy Woman Creek, stream bank, 8200 ft, *Nelson 3584*, in packet of *Bryum pallescens* (RM). Lincoln Co.: basalt outcrop, 6700 ft, *Hermann 25597*, as *Ceratodon purpureus* var. *dimorphus* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1.5 mi E of Barnes Lake, 10,080 ft, 42°58' N, 109°34' W, thin peat terrace, 17 May 1989, *Andrus 7866* (BING). Weston Co.: *Eckel 523686* (RM, BUF). Yellowstone Natl Park: 14 Aug 1925, *Frye s.n.* (RM); Yellowstone Park, *Taylor 67–161* (RM); Yellowstone Natl Park between Old Faithful and Madison near Great Fountain in *Pinus contorta* forest in northern exposures, primitive rocks, ca. 2460 m, *Duell 2265* (BUF).

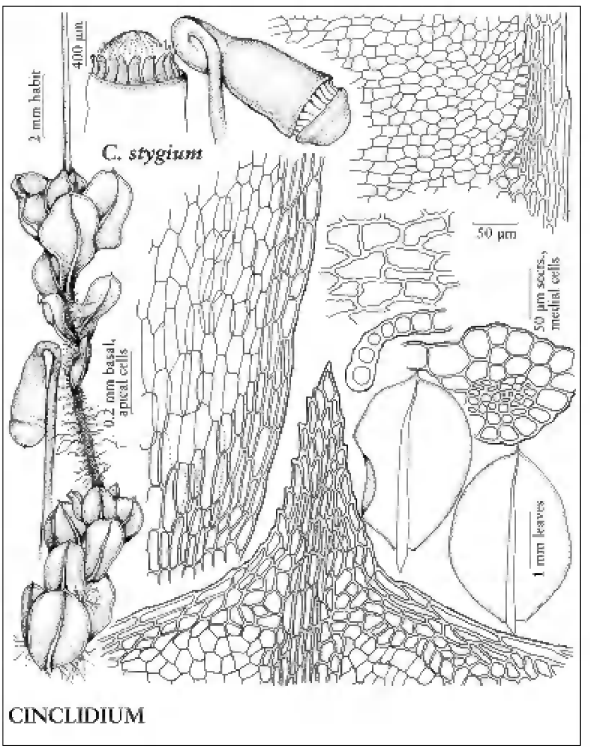
A weedy species found in almost every type of habitat, on soil, soil over rock, etc., in the Pacific Northwest on shaded roofs of houses in the city; cosmopolitan, extremely common, widespread throughout the United States and Canada. Distinguished from *Cynodontium* by leaves having no papillae, even on the margins; from *Oncophorus* by not being subulate and by being strongly revolute nearly to the apex; from *Dicranoweisia* species by either being recurved or not bistratose anywhere; from *Ditrichum* species by the non-subulate, non-awned leaves, by never being bistratose and by being recurved. When it has sharp pointed teeth at the apex, it is not a *Bryoerythrophyllum recurvirostrum* since its leaf cells are smooth (not papillose).

CINCLIDIUM Sw., J. Bot. (Schrader) 1801(1): 27, plate 2. 1803. (Mniaceae)

Cinclidium stygium Sw., J. Bot. (Schrader) 1801(1): 27, plate 2. 1803.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: wet marl in calcareous fen complex at the base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, Shoshone Natl. Forest, 6600 ft, 12 Aug 1990, *Elliott 1732* (BUF, NYS).

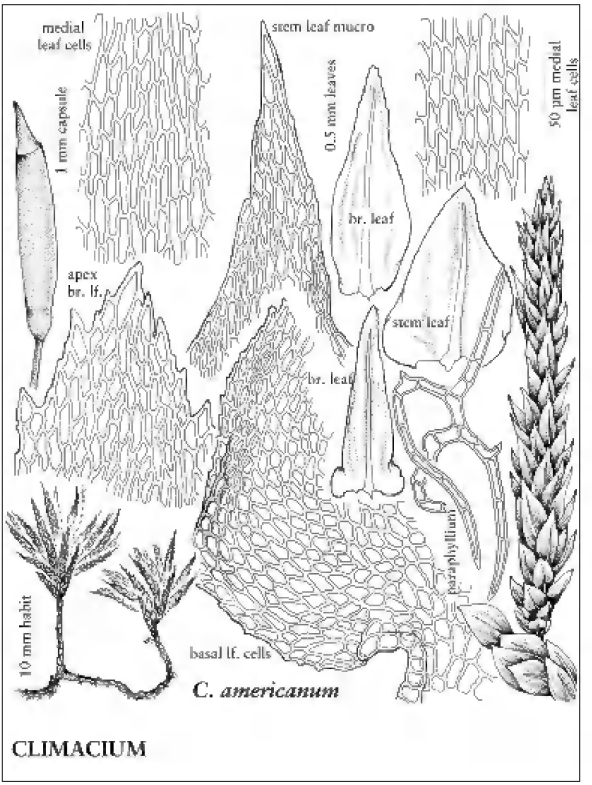


Courtesy FNA Association, FNA 28, 2014

Cirriphyllum cirrosum (Schwaegr. in Schultes) Grout = Brachythecium cirrosum (Schwägr.) Schimp.

CLIMACIUM F. Weber & D. Mohr in F. Weber, Naturh. Reise Schweden, 96. 1804. (Climaceaceae)

Climacium americanum Brid., Muscol. Recent., suppl. 2: 45. 1812.
Climacium americanum subsp. *kindbergii* (Ren. & Card.) Kindb.
Climacium americanum var. *kindbergii* Ren. & Card.
Climacium americanum var. *pseudokindbergii* Card. & Thériot
Climacium kindbergii (Ren. & Card.) Grout



Courtesy FNA Association, FNA 28, 2014

Wyoming (FNA Vol. 28, 2014). Lawton (1971: 235) does not distinguish *C. americanum* as separate from *C. dendroides*. "Specimens from Wyoming have been determined as C. *americanum*, and it is found in central and eastern North America as far south as Tennessee." Centennial, Albany County (*Nelson 1724*), Porter (1935). Teton Co., Spence (1985). (As *Climacium kindbergii*) "In a small peat bog," Carbon County (*Porter 1752*), Porter (1935).

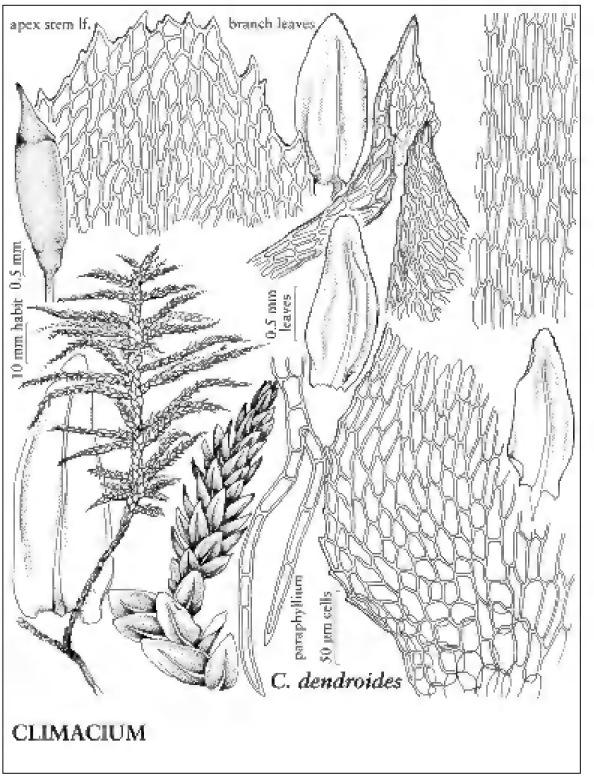
Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 42°57'30" N, 109°36' W, mineralized seeps at S end of lake, 9747 ft, 14 May 1989 *Andrus 7800,* auriculate leaves, short cells (BING).

This taxon is now accepted in the North American Checklist (Anderson et al. 1990). Crum & Anderson (1981: 1231) had regarded it as only a response to inundation, with plants long and trailing "somewhat like a *Fontinalis* is field appearance. The branching is irregular. The leaves are broadly rounded at the base but not particularly auriculate, the upper cells are rhombic and only about 2–4: 1, and a few large, lax cells are found in the alar region."

Climacium dendroides (Hedw.) F. Weber & D. Mohr in F. Weber, Naturh. Reise Schweden, 96. 1804.

Leskea dendroides Hedw., Sp. Musc. Frond., 228. 1801.

Climacium dendroides var. *oregonense* Ren. & Card.

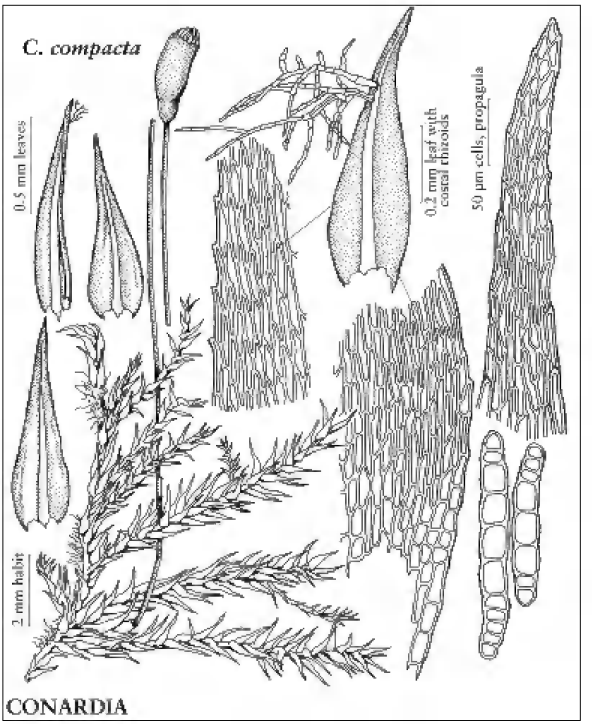


Courtesy FNA Association, FNA 28, 2014

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1532*), Roell (1893). In Park Co. *Climacium dendroides* forms a rich bryophyte community combined with *Aulacomnium palustre*, *Hylocomium splendens, Elodium blandowii, Rhizomnium* spp., *Thuidium recognitum, Marchantia alpestris*, (*Thuidium recognitum*, q.v.) and others" (Kosovich-Anderson & Weber 2011).

Yellowstone Natl Park, specimen number *1532,* Roell (1893). Albany County, Teton County, and Yellowstone Natl Park, Porter (1935). Albany, Carbon, Teton Cos., Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 9700 ft, *Sturges 250* (RM); Centennial Valley, 18 Aug 1895, *Nelson 1724* (RM). Carbon Co.: on the floating mat of a peat bog, near Silver Lake, Medicine Bow Mtns, 10,500 ft, *Porter 1752* (RM). Johnson Co.: Big Horn Natl Forest, Hunter Quadrant (A), Cloud Peak Wilderness Area, T50N R81W, Sect. 29, wet area W of Circle Park Campground, 8120 ft, 20 Aug 1992, *Zacharkevics s.n.* (BING). Park Co.: Beartooth Plateau, swales around small lakes, subalpine zone, Long Lake & lower Sheepherder Lakes, 2900 m, *Weber s.n.* (COLO, RM). Sublette Co.: 10,324 ft, *Rolston 85131* (c). Yellowstone Natl Park: along the Yellowstone River just above the Falls, on ground, 7 Jul 1934, *Frye s.n.* (RM).



Courtesy FNA Association, FNA 28, 2014

CONARDIA H. Robinson, Phytologia 33: 294. 1976. (Amblystegiaceae)

Conardia compacta (Hook.) H. Robinson, Phytologia 33: 295. 1976.
Hypnum serpens var. *compactum* Hook. in T. Drumm., Musc. Amer. 188. 1828.
Hypnum compactum Müll. Hal.

Amblystegium americanum Grout
Amblystegium compactum (Müll. Hal.) Aust.
Amblystegium dissitifolium Macoun & Kindb.
Amblystegium holzingeri (Grout) Grout
Amblystegium subcompactum Macoun & Kindb.
Brachythecium collinum var. *holzingeri* Grout
Rhynchostegiella compacta (Müll. Hal.) Loeske
Rhynchostegiella compacta subsp. *americana* (Grout) Wijk & Margadant

Not yet reported for Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: NW base of Sheep Mtn, along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula,* and *Salix*, *Buck 23249* (NY). Fremont Co.: Dubois, Fish Hatchery, 12 Aug 1953, *Lawton 1721,* c.fr. (WTU). Park Co.: wet soil in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 19 Apr 1992, *Elliott 1941* (BUF). Yellowstone Natl Park: Clematis Gulch Trail, 16 Aug 1953, *Lawton 1784,* c fr. (WTU).

Might be confused at first with *Campylium* because of the long, narrow leaf tips, but the costa here is longer—to the leaf tip to percurrent, which never happens in *Campylium*. Perhaps the most distinctive feature of this species are the marginal cells at the base that have sharp serrations which are heterogeneous in shape, one or two of which might appear to be recurved and may be composed of the top of one cell and the base of the one above it.

CODRIOPHORUS P.-Beauv., Mém. Soc. Linn. Paris 1: 445. 1822. (Grimmiaceae)

[*Codriophorus acicularis* (Hedw.) P.-Beauv., Mém. Soc. Linn, Paris 1: 445. 1823 (as aciculare), excluded]
Dicranum aciculare Hedw., Sp. Musc. Frond., 135. 1801.
Grimmia acicularis (Hedw.) Müll. Hal.
Grimmia nevii Müll. Hal.
Racomitrium aciculare (Hedw.) Brid.
Racomitrium nevii (Müll. Hal.) S. Watson
Trichostomum aciculare (Hedw.) P.-Beauv.

Not recognized for Wyoming but to be expected (FNA Vol. 27, 2007) in high elevations in the Rocky Mountains. Wyoming: Yellowstone Natl Park (*1453*), Roell (1893).)

[*Codriophorus fascicularis* (Hedw.) Bed.-Ochyra & Ochyra in R. Ochyra et al., excluded]
Racomitrium fasciculare (Hedw.) Brid.

Not recognized for Wyoming by FNA (FNA Vol. 27, 2007). (As *Racomitrium fasciculare*) "Jackson Lake, Teton County (Coulter, in 1872). No specimens of this species were found in the Rocky Mountain Herbarium, although the species is listed by Nelson (1900). "Has been reported for Wyoming as having been collected by Coulter in the northwest part of the State in 1872. No specimen of this collection has been seen by the writer, and it is believed that it should better be referred to the following species [*R. canescens*]. [This] species is a plant of more northern range," Porter (1935). Teton Co.: Spence (1985), however, Spence cites Porter (1935) for the occurrence of this species.

COSCINODON Sprengel, Anleit. Kenntn. Gew. 3: 281. 1804. (Grimmiaceae)

Coscinodon calyptratus (Drummond) C.E.O. Jensen in N. C. Kindb., Eur. N. Amer. Bryin. 2: 241. 1897.
Grimmia calyptrata Drumm., Musc. Amer., 60. 1828.
Coscinodon calyptratus (Hook.) C. Jens.in Kindb.
Coscinodon hookeri Hampe
Grimmia columbica Kindb.
Guembelia calyptrata (Hook.) Müll. Hal.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest; California, Arizona, New Mexico, Nevada, Utah, Colorado. Common on granite rocks, especially in the southern part of the State. Albany County (*Porter 1012, 480, 626*), Sublette County (*Porter 1124)*, Porter (1935). Weston Co., Wynne (1943). Campbell Co., Medina (1994).

Albany Co.: crevice in granite boulder in Lodgepole woods above Libby Creek Picnic Ground, Snowy Range, 2 1/2 mi NW of Centennial, 8700 ft, 7 Jun 1972, *Hermann 24864* (RM); Willow Creek, 22 May 1897, *Nelson 2917* (RM). Big Horn Co.: Big Horn Natl. Forest, Lake Helen Quad., Cloud Peak Wilderness Area, 10,200 ft, 3 Aug 1992, *Zacharkevics s.n.* (BING). Lincoln Co.: tight dense polsters on boulder in Greys River, 7 mi S of Twin Creek, Salt River Range, 44 mi SSE of Alpine Junction, 6700 ft, 30 Aug 1973, *Hermann 25605* (RM). Platte Co.: *Eckel 820386* (RM, BUF). Park Co.: 10 Jun 1990, *Parsons s.n.* (BUF, RM). Sweetwater Co.: on the sides of a big rock, Bush Ranch, 10 Jun 1900, *Nelson 7092* (RM), exsiccat. Plants of Wyoming (as *Grimmia alpestris*).

This species has large areas of cells that are subsinuose, including the basal region. Most striking perhaps is the broad base of the awn confluent with the upper lamina.

CRATONEURON (Sull.) Spruce, Cat. Musc., 21. 1867. (Amblystegiaceae)

One must find the filamentous paraphyllia on the stem or one will probably think one is looking at a *Drepanocladus* (whose paraphyllia, when seen, are oriented to the leaf bases, not scattered generally over the stem). Illustrations of this genus tend to emphasize the deltoid forms, but c. *commutatum* looks more often than not exactly like a *Drepanocladus*, with thick walled basal/alar cells. It has long leaf cells and can be subentire except perhaps at the base and tip of the leaf. Also, in *Cratoneuron* (*commutatum*) the stem is thick and wiry, noticeable when attempting to strip leaves off—the leaves like as not will shred themselves. *Drepanocladus* stems are softer and the leaves do not disintegrate so readily.

[Cratoneuron commutatum (Hedw.) Roth = Palustriella commutata (Brid.) Ochyra, q.v.; excluded]

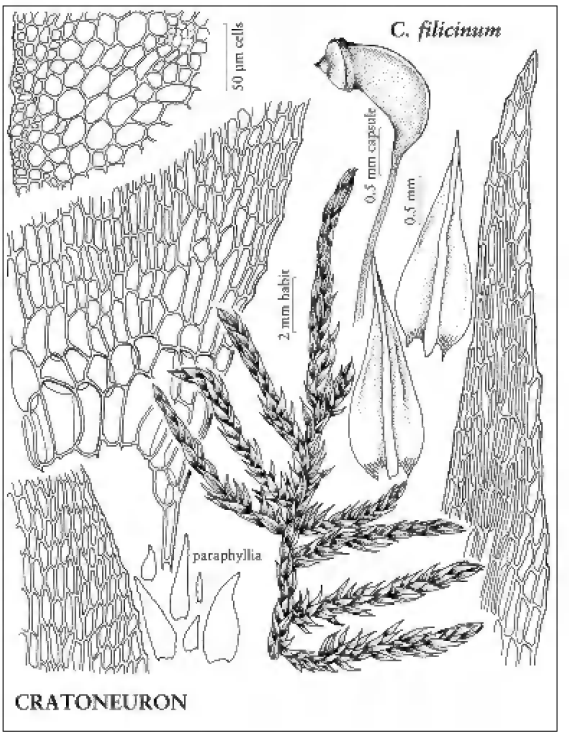
Cratoneuron falcatum (Brid.) G. Roth = Palustriella falcata (Brid.) Hedenäs

Cratoneuron filicinum (Hedw.) Spruce, Cat. Musc., 21. 1867.
Hypnum filicinum Hedw., Sp. Musc. Frond., 285, plate 76, figs. 5–10. 1801.
Amblystegium tenax var. *spinifolium* (Schimper) H.A. Crum & L.E. Anderson
Cratoneuron filicinum var. *aciculinum* (Müll. Hal. & Kindb.) Grout
Cratoneuron curvicaule (Jur.) G. Roth
Cratoneuron filicinum var. *curvicaule* (Jur.) Mönk.

Wyoming (FNA Vol. 28, 2014). (As *Hypnum filicinum*) Wyoming: Yellowstone Natl Park (*1566a, 1850*) (Roell 1893). Albany County, Carbon County, Crook County, Sublette County, and Yellowstone Natl Park, Porter (1935). Albany, Crook, Sublette cos., Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: NW base of Sheep Mtn., along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula*, and *Salix*, *Buck 23231* (NY). Carbon Co.: Ferris Mts., in a packet at US of *Bryum turbinatum*, 25 Jul 1898, *Nelson 4978* (RM). Crook Co.: *Nelson 1896* (RM). Lincoln Co.: 6400 ft, *Hermann 25589* (RM). Natrona Co.: S of I-25, WY 252. Rotary Club Park in N-slope foothills, creek ravine, *Salix, Ribes, Alnus,* granite, with *Campylium chrysophyllum*, 7 Jul 1985, *Eckel 94100401* (BUF). Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1720* (BUF). Teton Co.: 7000 ft, *Hermann 25563* (RM); on US 26 & US 237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus, Asters,* wooded stream, soggy debris, ca. 9000 ft, 6 Jul 1985, *Eckel 94082105* (BUF).

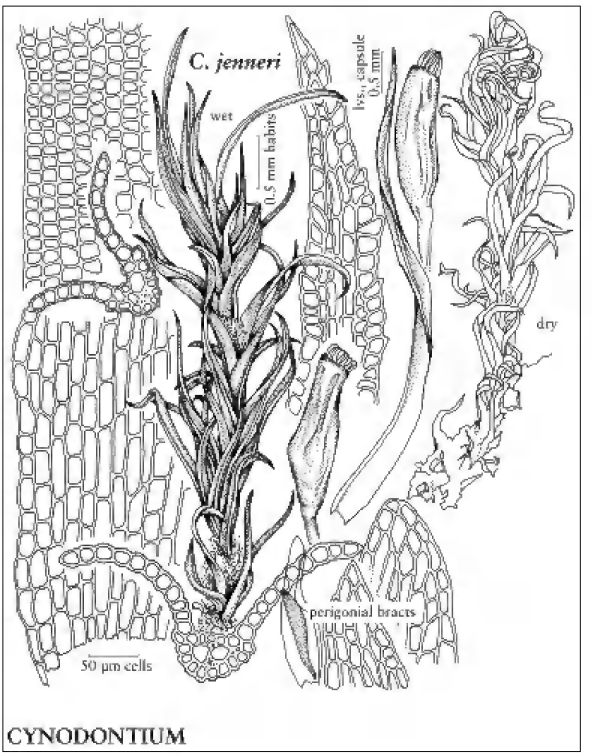
Care must be taken that this species is not confused with *Drepanocladus aduncus* forms such as var. *kneiffii*, which has long leaf cells and a channeled acumen in some forms and no serrations on the margin.



Courtesy FNA Association, FNA 28, 2014

CYNODONTIUM P. Bruch & Schimp. in W.P. Schimper, Coroll. Bryol. Eur., 12. 1856, name conserved. (Dicranaceae)
Cnestrum I. Hagen

[*Cynodontium alpestre* (Wahlenberg) Milde, Bryol. Siles., 51. 1869. [not present in Wyoming]
Dicranum alpestre Wahlenberg, Fl. Lapp., 339, fig. 21. 1812.
Cnestrum alpestre (Wahlenberg) Nyholm
Cynodontium subalpestre Kindb. in Macoun
Cynodontium tenellum (B.S.G.) Limpr.
Cynodontium torquescens Limpr.
Dicranum gracilescens var. *tenellum* B.S.G.
Oncophorus tenellus (B.S.G.) R.S. Williams



Courtesy FNA Association, FNA 28, 2014

Not yet reported for Wyoming (FNA Vol. 27, 2007), but should be expected. British Columbia, Alberta, Montana, Wyoming, Alaska, Northwest Territory; Saskatchewan, Manitoba, Ontario, South Dakota, Minnesota, Michigan; Greenland, Labrador, Nova Scotia, Quebec, New England, New York.

Cynodontium jenneri (Schimper) Stirton, Ann. Scott. Nat. Hist. 15(58): 106. 1906.
Didymodon jenneri Schimper, Trans. Bot. Soc. Edinburgh 9: 314, fig. 5. 1886.
Cynodontium polycarpum var. *laxirete* (Schimper) Stirton

Wyoming (FNA Vol. 27, 2007).

Cynodontium polycarpon (Hedw.) Schimp., Coroll. Bryol. Eur., 12. 1856.
Fissidens polycarpos Hedw., Sp. Musc. Frond., 159. 1801.
Oncophorus polycarpus (Hedw.) Brid.

Wyoming (FNA Vol. 27, 2007).

(As *Cynodontium polycarpum* (Ehrh.) Schimp.): Wyoming: Yellowstone Natl Park. 7000' (1439 p.p., 1440 p.p.). Hab.: Felsen." (Roell 1893). (As *Oncophorus polycarpus* (Hedw.) Brid.) Mammoth and Yellowstone Canyon, Yellowstone Natl Park (*R.S.Williams*), Porter (1935). (As *Oncophorus polycarpus* (Hedw.) Brid.) Yellowstone Natl Park, Porter (1937). Excluded from the flora of North America by Crum et al. (1973).

Cynodontium schisti (Web. & Mohr) Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 21: 230. 1864.
Grimmia schisti Web. & Mohr, Index Mus. Pl. Crypt., (2). 1803.
Cnestrum schisti (Wahlenberg) I. Hagen
Cynodontiella schisti (Web. & Mohr) Bryhn
Grimmia schisti Web. & Mohr
Oncophorus brevipes Lindb.
Oncophorus schisti (Web. & Mohr) Lindb.
Rhabdoweisia schisti (Web. & Mohr) B.S.G.
Weissia schisti (Web. & Mohr) Brid.

Wyoming (FNA Vol. 27, 2007). British Columbia, Alberta, Montana, Wyoming; Alaska, South Dakota, Michigan, Ontario; Quebec (FNA). (As *Oncophorus schisti)* Albany Co., Porter (1937).

Desmatodon cernuus (Hüb.) P. Bruch & Schimp. in B.S.G. = Tortula cernua (Hüb.) Lindb.

Desmatodon guepinii P. Bruch & Schimp. in B.S.G. = Tortula guepinii P. Bruch & Schimp.

Desmatodon heimii (Hedw.) Mitt. = Hennediella heimii (Hedw.) R.H. Zander

Desmatodon latifolius (Hedw.) Brid. = Tortula hoppeana (Schultz) Ochyra

Desmatodon leucostoma (R.Br.) Berggr. = Tortula leucostoma (R. Brown) Hook. & Grev.

Desmatodon obtusifolius (Schwägr.) Schimp. = Tortula obtusifolia (Schwägr.) Mathieu

Desmatodon plinthobius Sull. & Lesq. in Sull. = Tortula plinthobia (Sull. & Lesq.) Broth. in H. G. . Engler and K. Prantl

Desmatodon porteri (James) in C.F. Aust. = Tortula porteri (James) Broth. in H.G. Engler and K. Prantl

Desmatodon systylius Schimp. = Tortula systylia (Schimp.) Lindb.

DICHELYMA Myrin, Kongl. Vetensk. Acad. Handl. 1832: 273, plates 6, 7. 1833. (Fontinalaceae)

Dichelyma falcatum (Hedw.) Myrin, Kongl. Vetensk. Acad. Handl. 1832: 274. 1833.
Fontinalis falcata Hedw., Sp. Musc. Frond., 299. 1801.

Wyoming (FNA Vol. 28, 2014). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: 2900 m, *Weber B–44282* (RM, COLO).

Dichelyma uncinatum Mitt., J. Linn. Soc., Bot. 8: 44, plate 8 (upper left). 1864.
Dichelyma cylindricarpum Aust.
Dichelyma falcatum var. *uncinatum* (Mitt.) Lawton
Dichelyma uncinatum var. *cylindricarpum* (Austin) Card.

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (Roell 1893).

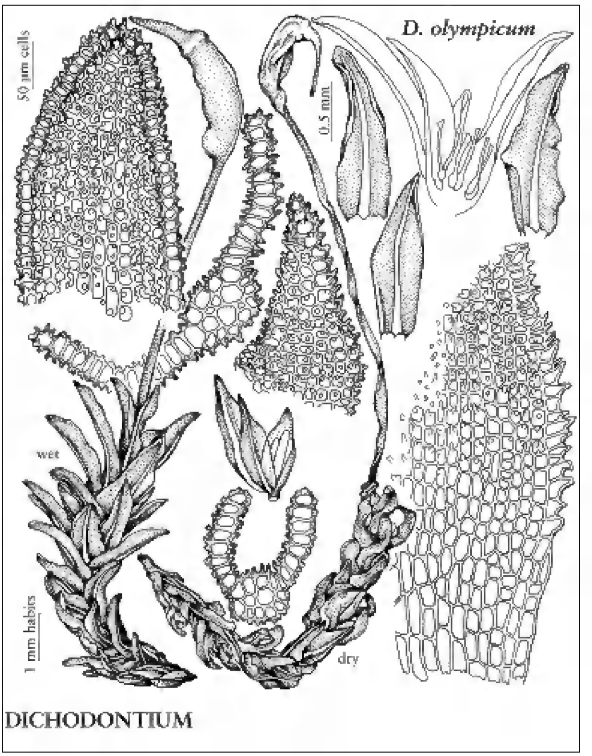
Yellowstone Natl Park: (Lost Lake near Roosevelt Lodge, with *Calliergonella conardii* Lawt., 28 Aug 1951, *Lawton 1495* (WTU).

DICHODONTIUM Schimp., Coroll. Bryol. Eur., 12. 1856. (Dicranaceae)

Dichodontium olympicum Ren. & Card., Bot. Gaz. 17: 296. 1892.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). Brooklyn Lake, Albany County (*Nelson 5178*), Porter (1935).

Albany Co: La Plata Mines, 25 Aug 1898, *Nelson 5178* (RM).

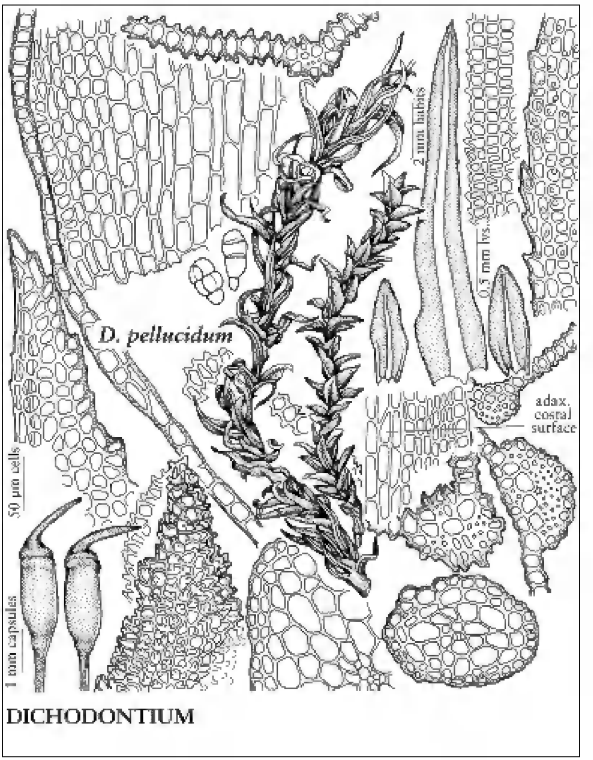


Courtesy FNA Association, FNA 27, 2007

Dichodontium pellucidum (Hedw.) Schimp.,Coroll. Bryol. Eur., 12. 1856.
Dicranum pellucidum Hedw., Sp. Musc. Frond., 142. 1801.
Bryum flavescens Dickson ex Withering
Dichodontium flavescens (Dickson ex Withering) Lindb.
Dichodontium pellucidum var. *americanum* Lesq. & James
Dichodontium pellucidum var. *fagimontanum* (Brid.) Schimp.
Dichodontium subflavescens Kindb.

Not reported for Wyoming (FNA Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 9800 ft, c.fr., 1 Sep 1970, *Hermann 23423* (RM); Medicine Bow Mountains, Barber Lake Picnic area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest, on rock streamside, 7 Jun 1993, *Miller 10,261B* (NYS) plus *Brachythecium nelsonii*.



Courtesy FNA Association, FNA 27, 2007

DICRANELLA (Müll. Hal.) Schimp., Coroll. Bryol. Eur., 13. 1856, name conserved. (Dicranaceae)

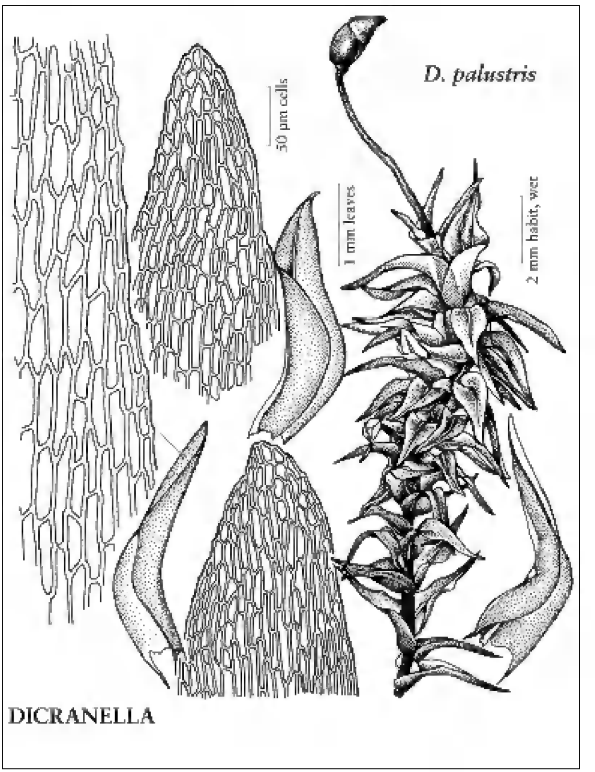
Dicranella crispa (Hedw.) Schimp., Coroll. Bryol. Eur., 13. 1856.
Dicranum crispum Hedw., Sp. Musc. Frond., 132. 1801.
Anisothecium crispum (Hedw.) Lindb.
Anisothecium vaginale (Withering) Loeske
Bryum vaginale Dicks.

Wyoming (FNA Vol. 27, 2007).

Dicranella palustris (Dickson) E.F. Warburg, Trans. Brit. Bryol. Soc. 4(2): 247. 1962.
Bryum palustre Dickson, Fasc. Pl. Crypt. Brit. 4: 11. 1801.
Dicranella squarrosa (Schrader) Schimp.

Not yet reported for Wyoming in FNA Vol. 27, 2007. "I collected new in the Rocky Mountains *Dicranum palustre* La Pyl. var. *schlotthaueri* Barn. in Yellowstone Natl Park, Wyom. ..." (Roell 1893).

Park Co. Beartooth Plateau, Shoshone Natl Forest, Forest Road 130 1A, Gilbert Creek, roadside, *Carex* spp.—Bryidae fen and moist meadow along creek bank, on damp clayey soil in seepage, T57N R108W S1, 44°57.380–385' N, 109°44.280–285'W, 2350 m, 31 Jul 2010, *Kosovich-Anderson 7591* (RM, US, det. R. Ireland), *same 7593* (RM, det. by the author) (see also Kosovich-Anderson 2011b).



Courtesy FNA Association, FNA 27, 2007

Dicranella schreberiana (Hedw.) Hilferty ex H.A. Crum & L.E. Anderson, Mosses E. N. Amer. 1: 169. 1981.
Dicranum schreberianum Hedw., Sp. Musc. Frond., 144, plate 33, figs. 6–10. 1801.
Anisothecium grevillianum (Brid.) Arnell & C.E.O. Jensen

Anisothecium schreberianum var. *elatum* (Schimp.) Wijk & Margadant
Anisothecium. schreberianum (Hedw.) Dixon
Cynodontium canadense Mitt.
Dichodontium canadense (Mitt.) Lesq. & James
Dicranella schreberi (Sw. ex Anonymous) Schimp.
Dicranella schreberi var. *occidentalis* Aust.
Dicranella canadense (Mitt.) Aust.
Dicranella grevilliana (Brid.) Schimp.
Dicranella schreberi var. *elata* Schimp.
Dicranella schreberi var. *elata* Schimp.
Dicranella schreberi var. *grevilliana* (Brid.) Mönk.
Dicranella schreberi var. *lenta* (Braithw.) Limpr.
Dicranella schreberi var. *robusta* Braithwaite
Dicranella schreberiana var. *robusta* (Braithwaite) H.A. Crum & L.E. Anderson
Leptotrichum canadense (Mitt.) A. Jaeger

Wyoming (FNA Vol. 27, 2007). British Columbia, Washington, Oregon, Alberta, Montana; Alaska; South Dakota, Michigan, Ontario; Labrador, Quebec, New York, Ohio, Pennsylvania, New Jersey.

Albany Co.: Steep, peaty bank of Friend Creek in willow thicket, 7800 ft, NW base of Laramie Peak 19 mi SSW of Esterbrook, 25 Sep 1974, *Hermann 25928* (RM); Medicine Bow Natl Forest, 26 mi SE of Laramie, moist peaty bank of Crow Creek in clearing, 8000 ft, 5 Jul 1974, *Hermann 25702,* c.fr. (RM). Johnson Co:, UTM 13 334577 E 4889076 N, on soil, in edge of stream, with grasses, sedges, *Salix* sp., surrounded by forest of *Pinus contorta* & *Picea engelmannii*, near head of North Fork Powder River, ca. 1 air mi SE of Powder River Pass, Bighorn Natl Forest, 2794 m, 31 Aug 2005, *Lenz 2426* (RM).

All four species in *Dicranella* from Wyoming have red (not yellow) setae, especially when old. The Lenz specimen represents the var. *robusta* (Schimp. ex Braithw.) Crum & Anderson, with blunt leaves, with "margins bluntly and irregularly serrulate to serrate with coarse teeth form by projections of marginal cells" (Crum & Anderson 1981). The cells are larger, the leaf bases are gradually tapered from the shoulders above the clasping base to the apex. The strong serrations develop from the apex to the base.

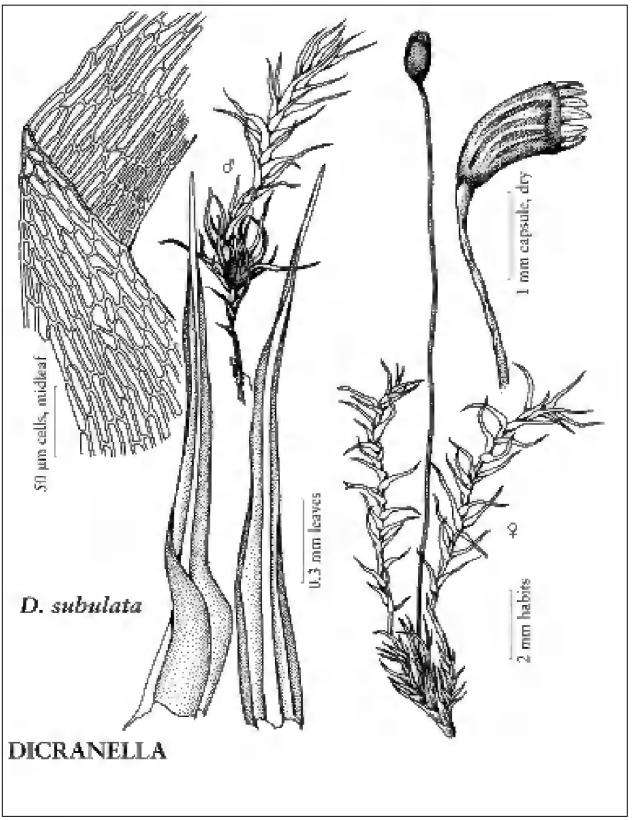
The leaves of *Dicranella schreberiana* are strongly crisped, wet or dry. *Dicranella schreberiana* is separated from *D. crispa* by the unistratose leaves (bistratose in parts). *Dicranella crispa* is bistratose in both margins and lamina in the distal part of the leaf. All four Wyoming species have leaves weakly to strongly squarrose on the stem, linear in the spreading upper part (the limb) from an enlarged, more or less erect, clasping or sheathing base. Other species in the genus have erect leaves from a spreading base. Both *D. schreberiana* and *D. palustris* have cells on the shoulders that are nearly isodiametric to short-rectangular (2–3:1), especially on the margins, but the leaves on *D. palustris* are long-decurrent with a blunt apex. They are not excurrent at all in *D. schreberiana* with an acute apex.

All the cells of species of *Onchophorus* are small and quadrate to short-rectangular, with no elongate, narrow rectangular cells. *Dichodontium* and *Cynodontium* have coarse mammillae or papillae on the leaves. Species of Dicranum have colored cells at the leaf base, especially in the alar region.

Dicranella subulata (Hedw.) Schimp., Coroll. Bryol. Eur., 13. 1856.
Dicranum subulatum Hedw., Sp. Musc. Frond., 128, figs. 1–5. 1801.
Dicranella curvata (Hedw.) Schimp.
Dicranella secunda Lindb.
Dicranella stikinensis Grout
Dicranella subulata var. *curvata* (Hedw.) Rabenhorst

Wyoming (FNA Vol. 27, 2007). British Columbia, Washington, Alberta, Idaho, Montana, Wyoming; Alaska, Yukon, California; Greenland, Labrador, New Brunswick, Quebec, New England, Ireland (1982). (As *Dicranella curvata* Schimp.) Porter (1935), reported for Yellowstone Canyon, Yellowstone Natl Park.

Albany Co.: Lewis Lake, 10,800 ft, *Hermann 17715* 1/2 (RM). Carbon Co.: North French Creek, Medicine Bow Mts., 9500 ft, *Hermann 17204* (RM). Yellowstone Natl Park: in slough, left of the first bridge, Uncle Tom's Trail, 1 Aug 1932, *Smiley 165* (YELLO), fruit just immature, calyptrate.



Courtesy FNA Association, FNA 27, 2007

DICRANOWEISIA Lindb. ex Milde, Bryol. Siles., 48. 1869. (Dicranaceae)

Dicranoweisia cirrata (Hedw.) Lindb. in C. Milde, Bryol. Siles., 49. 1869.
Weissia cirrata Hedw., Sp. Musc. Frond., 69. 1801.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). "Wyoming: Yellowstone Natl Park, 7000 ft (*1439* p.p., *1440* p.p.) ... auf Holz, an Baumzweigen und an Felsen" (Roell 1893). Albany, Bighorn, Sublette, Teton cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985).

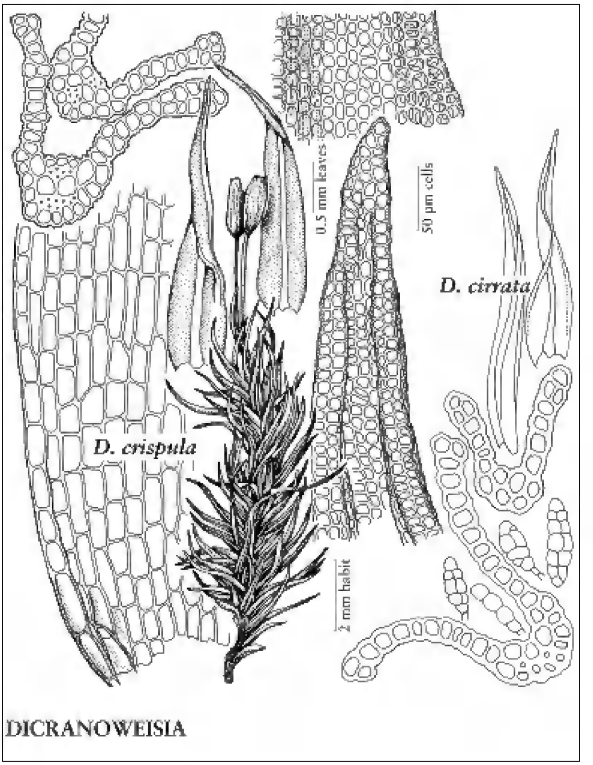
Yellowstone Natl Park: Holz. examined, *Nelson & Nelson 5892* (RM).

Dicranoweisia crispula (Hedw.) Milde, Bryol. Siles., 49. 1869.
Weissia crispula Hedw., Sp. Musc.Frond., 68. 1801.
Dicranoweisia contermina Ren. & Card.
Dicranoweisia crispula var. *compacta* (Schwägr.) Lindb.
Dicranoweisia crispula var. *contermina* (Ren. & Card.) Grout
Dicranoweisia crispula var. *roellii* (Kindb. in Roell.) Lawt
Dicranoweisia roellii Kindb.
Trichostomum alpinum Kindb.
Weissia compacta Schwägr.
Weissia convoluta Müll. Hal. & Kindb. in Macoun

Wyoming (FNA Vol. 27, 2007). Throughout the Pacific Northwest; Alaska, Yukon, California, Nevada, Utah, Colorado: Michigan. Sheep Mountain, Albany Co (*Nelson 3312*); Tower Falls, Yellowstone Natl Park (Bartram and Williams, Porter (1935). "Common in front of glaciers", Teton Range, Grand Teton Natl Park, Wyoming (Spence 1981). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As var. *crispula*): Albany Co.: granite boulder on aspen slope along N Fork of Little Laramie River, Sand Lake Rd., 8500 ft, Medicine Bow Mts., 3 mi W of Centennial, 4 Aug 1962, *Herman 17743*, c.fr., (RM); Medicine Bow Mtns, Barber Lake Picnic area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest, growing from crevice of boulder, 7 Jun 1993, *Miller 10,255* (NYS). Park Co.; on rocks 2900 m, *Weber B–44232* (COLO, RM); 2900 m, *Weber B–44232* (COLO, RM). Big Horn Co.: Big Horn Natl. Forest, Lake Helen Quandrant, Cloud Peak Wilderness Area, 10,200 ft, 3 Aug 1992, *Zacharkevics s.n.* (BING). Fremont Co: Bridger-Teton Natl Forest on US 26 & US 287, between Moran & Dubois, ca. 9000 ft, alpine meadow, much herbage, wet with flowing streams, W slopes of knoll, *Eckel 9308103,* c.fr. (BUF); near border with Teton Co., between Moran and Dubois twps., on US 26, E of Togwotee pass, ca. 9000 ft at 63.0; S-facing, spruce and 2- & 5-needle pines, herbaceous, not species-abundant slope, *Artemisia tridentata* here and there, on granite, with *Brachythecium collinum*, 6 Jul 1985, *Eckel s.n.*. (MO). Park Co.: granite bluff along Route 212, Shoshone Natl. Forest, 7500 ft, 47 mi NW of Cody, 19 Jul 1965, *Herman 20050* (RM). Sheridan Co.: limestone boulder in spruce-fir forest, Big Horn Natl Forest, T57N, R89W, Sect. 34, 19 Jun 1992, *McKee 92-F4* (RM) c.fr., with *Hypnum cupressiforme, Tortella tortuosa, Tortula norvegica.* (var. *contermina*). Sublette Co.: 7950 ft, *Hermann 25320* (RM); Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 10,290 ft, 42°59'N, 109°34'W, on damp rock at edge of fen, 16 May 1989, *Andrus 7837* (BING). Teton Co.: Crystal Creek, on downed, decaying lodgepole pine, common, 7 Jul 1977, *Lichvar 677,* c.fr.(RM); 2250 m, wet rock, *Duell 2257/2 (*BUF); perichaetial bracts muticous, blunt, basal cells more or less enlarged, brown-tinged, boulder on open slope along Hidden Falls Trail, NW of Jenny Lake, 7000 ft, Teton Range, Natl Park, 29 Aug 1973, *Hermann 25554*, fruit in spears (RM). Yellowstone Natl Park: on US 14, 16 & 20 just before E entrance to Park, border with Shoshone Natl Forest, 6951 ft, granitic rocks, spruce-pine woods, *Juniperus* woodland, xeric S slope, c.fr., 6 Jul 1985, *Eckel 94082302* (BUF, RM); on stump,

in Clematis Gulch opposite the reservoir, 29 Jul 1932, *Smiley 46,* c.fr., dehisced (det. as *Weisia wolfii*) (YELLO); on large boulder in shade, Old Faithful, Observation Point Trail, 1 Aug 1932, *Smiley 93* (YELLO), fruit in spears (as *Weisia wolfii*); on boulder, Old Faithful, Observation Point Trail, 1 Aug 1932, *Smiley 159* (YELLO) (as *Weissia convoluta*).



Courtesy FNA Association, FNA 27, 2007

The dried capsules, though not longitudinally striate as in *Cynodontium*, are irregularly so (rugose) with rugae "squirming" on the capsule surface. Note also how like *Ceratodon purpureus* the leaves are, with their deeper channeling, toothed or stepped apical margins and box- like cells (square). The double layer of cells is distinctive. Occasionally the characteristic longitudinal striations are quite visible in cells just above the basal cells; they may be high enough to be discerned by the shallow depth of field under high magnification (x570). If the striae are not very high, a cross Sect. is necessary. The leaves of this species are not recurved but appear to be that way because of the double to triple cell layers at the extreme margins—a Sect. is definitive.

In the variety *crispula*, the inner perichaetial leaves are convolute- sheathing, with no limb, obtuse to acute. In the var. *contermina*, there is a limb in the inner perichaetial leaves, the perichaetial leaves tend to be acuminate.

Europeans and Crum and Anderson (1981) did not refer to a var. *contermina*. The inflated basal cells of the typical variety are not demonstrated in this variety, or only occasionally. Perhaps specimens in the western United States lose the distinction of this characteristic. However, the perichaetial leaves do not correlate: convolute leaves with no limb or awn may be found with leaves with no inflated alar cells. According to Flowers (1973) "Since most of our plants have undifferentiated alar cells associated with acute to broadly obtuse convolute-clasping inner perichaetial leaves, var. *contermina* loses much of its supposed individuality and rests only on the clasping but scarcely convolute inner perichaetial leaves with rather long acuminate upper portions."

DICRANUM Hedw., Sp. Musc. Frond., 126. 1801. (Dicranaceae)

Dicranum acutifolium (Lindb. & Arnell) C.E.O. Jensen in H. Weimarck, Förtekn. Skand. Växt., Moss. ed. 2 18. 1937.
Dicranum bergeri var. *acutifolium* Lindb. & Arnell, Kongl. Svenska Vetensk. Acad. Handl., n. s. 23(10): 79. 1890.

Wyoming (FNA Vol. 27, 2007). "(Leaf) margins ... are almost completely 2-stratose" (Ireland, FNA Vol. 27, 2007).

Dicranum bonjeanii De Not. in D. Lisa, Elenc. Musch., 29. 1837.

Wyoming (FNA Vol. 27, 2007). (With *Dicranum palustre* La Pyl. as synonym:) Wyoming: Yellowstone Natl Park (1443). (Roell 1893). Roell had particular difficulty distinguishing his *D. bonjeanii* from *D. scoparium*, "Approximately half of this material (1443) appears typical enough. The rest is similar to those from Seattle (166)" (Roell 1893). Roell described a new variety of *D. bonjeanii*, var. *schlotthaueri* from Yellowstone, 7000 ft (1441).

Usually synonymized with *Dicranum scoparium* (Ireland, FNA Vol. 27, 2007), but recognized by many as distinct. "...both species are distinctive ecologically: *D. bonjeanii* prefers eutrophic fens, whereas *D. scoparium* usually grows in decidedly dry to mesic woodlands, on soil, humus, humus over rock, stumps and logs, tree bases, etc." (Ireland, FNA Vol. 27, 2007).

Dicranum elongatum Schwägr., Sp. Musc. Frond. Suppl. 1(1): 171, plate 43. 1811.

Not reported for Wyoming in FNA (FNA Vol. 27, 20070. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: SNF, Beartooth Plateau, 0.8 km E of Christmas Lake, head of an unnamed tributary to Littlerock Creek, alpine fen, north-central portion of fen, *Salix planifolia—Carex scopulorum*, abundant in hummocks, on peaty soil, T58N, R104W, S34, 44°57,930–58,015'N, 109°24,820–850'W, 3245 m, 21 Aug 2008, *Kosovich-Anderson 3593* (COLO, MO, RM), also *3611, 3624, 3640, 3664, 3676* (Kosovich-Anderson 2011a).

Dicranum fuscescens Turner, Muscol. Hibern. Spic., 60, plate 5, fig. 1. 1804.

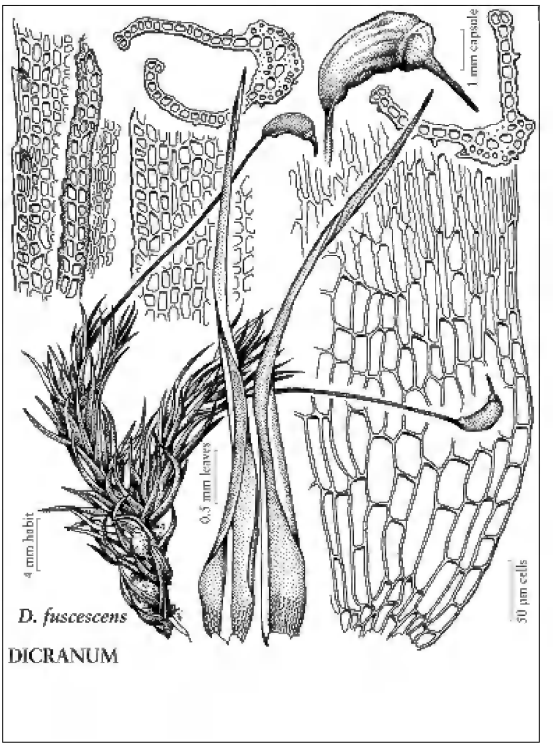
Var. **fuscescens**

Dicranum camptophyllum Kindb.
Dicranum congestum Brid.
Dicranum crispulum Müll. Hal. & Kindb. in Macoun
Dicranum fuscescens var. *congestum* (Brid.) Husnot
Dicranum leucobasis Müll. Hal. & Kindb. in Macoun
Dicranum sulcatum Kindb. in Macoun
Dicranum sulcatum Kindb.
Dicranum trachyphyllum Ren. & Card.

Wyoming (FNA Vol. 27, 2007). Throughout the Pacific Northwest; Alaska, Yukon, California, Colorado; Minnesota, Michigan, Ontario; Greenland and Labrador to Florida.

Yellowstone Natl Park: Clematis Gulch Trail, 16Aug 1953, *Lawton 1799* (YELLO).

Distinct from *D. acutifolium* by leaf margins that are mostly 1-stratose (Ireland, FNA Vol. 27, 2007). There is a var. *flexicaule* (Brid.) Wils. in the 1990 checklist.



Courtesy FNA Association, FNA 27, 2007

Dicranum muehlenbeckii P. Bruch & Schimp., Bryol. Europ. 1: 142, plate 78. 1847.
Dicranum rauei Aust.

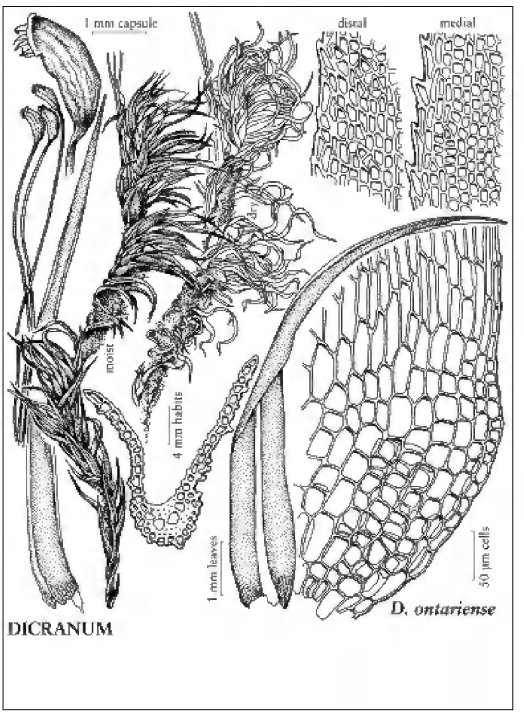
Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park, 7000 ft(1444, 1445 p.p.), "these specimens are sterile and are perhaps to be compared with *Drcranum fuscescens*" (Roell 1893). (Rare) British Columbia, Alberta, Montana, Wyoming; Alaska, Northwest Territory, Colorado; North Dakota, Ontario; Quebec, New England. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Pass, 3200 m, *Weber B–44303* (COLO, RM); hummock in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1742* (BUF).

"... a somewhat rare species throughout North America" (Ireland, FNA Vol. 27, 2007).

Dicranum ontariense W.L. Peterson, Canad. J. Bot. 55: 988. 1977.
Dicranum drummondii Sull. ex Lindb., Bot. Not. 1865: 79. 1865, not Müll. Hal. 1848.

Wyoming (FNA Vol. 27, 2007). "This is a North American endemic species that was previously mistaken for *D. drummondii* Müll. Hal., a predominantly Eurasian species which was unknown on this continent until it was discovered just recently on the Aleutian Islands" (Ireland, FNA Vol. 27, 2007).



Courtesy FNA Association, FNA 27, 2007

Dicranum polysetum Sw., Monthly Rev., ser. 2, 34: 538. 1801.
Bryum rugosum Hoffm. ex Funck
Dicranum rugosum (Funck) Hoffm. ex Brid.
Dicranum undulatum Ehrh. ex Web. & Mohr

Wyoming (FNA Vol. 27, 2007). British Columbia, Washington, Alberta, Montana, Wyoming; Alaska; widespread in the Middle West, Manitoba to Michigan, south to South Dakota, Iowa, and Illinois; Newfoundland and Nova Scotia to North Carolina. Rare (As *D. rugosum*), Weston Co., Wynne (1943). Ireland (1982). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

"It is one of the largest, most conspicuous, and most easily recognized species in the genus in North America" (Ireland, FNA Vol. 27, 2007).

Dicranum rhabdocarpum Sull., Mem. Amer. Acad. Arts, n. s. 4: 172. 1849.
Dicranum scoparioides Schimp. in Besch.
Orthodicranum rhabdocarpum (Sulliv.) Holz.

Wyoming (FNA Vol. 27, 2007). Wyoming; Colorado, New Mexico, Arizona. Lawton. On the Colorado-Wyoming line, Albany County (Porter 1756). Teton Co., Spence (1985).

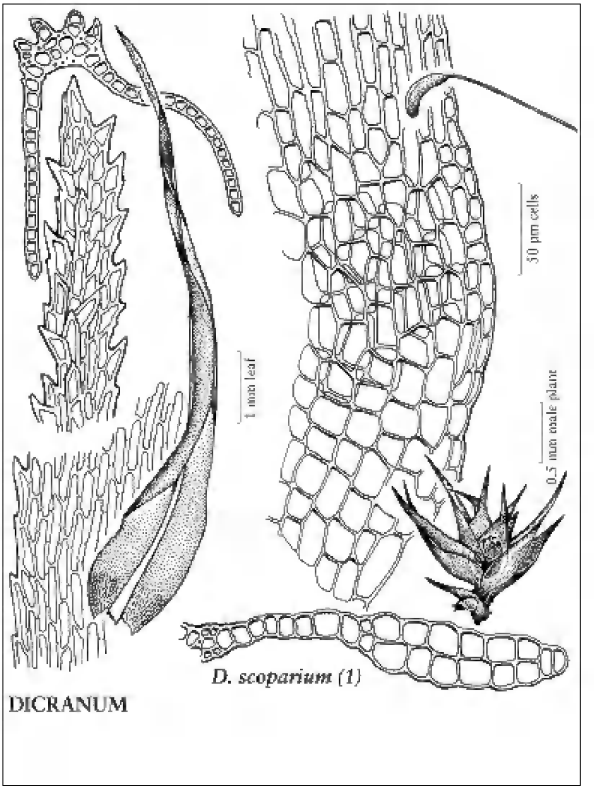
Yellowstone Natl Park: on the drier shaded ground near the lake shore, Beaver Lake, *Nelson & Nelson 6125* (RM); 24 Jul 1899, exsiccat, det. R. H. True. (Originally as *D. bonjeani*). Verified by R. Ireland, CANM 1991.

"... an easily recognized species that occurs in the flora area only in the Rocky Mountains and the mountains of Arizona" (Ireland, FNA Vol. 27, 2007).

Dicranum scoparium Hedw., Sp. Musc. Frond., 126. 1801.
Dicranum angustifolium Kindb. in Macoun
Dicranum canadense Kindb., in Macoun
Dicranum kindbergii Par.
Dicranum latifolium J.J. Amann
Dicranum mexicanum Schimp. in Besch.
Dicranum pallidum P. Bruch & Schimp. ex Müll. Hal.
Dicranum scopariforme Kindb.

Wyoming: Yellowstone Natl Park, 7000 ft (1442). (Roell 1893). Throughout the Pacific Northwest; Alaska, Colorado; South Dakota, Minnesota, Iowa, Michigan, Ontario; Newfoundland, New Brunswick and Quebec to Georgia and Alabama. Albany, Teton cos., Porter (1937). Teton Co., Spence (1985). (As *Dicranum bonjeani* DeNot.) (Albany Co.), Beaver Lake, Yellowstone Natl Park (Nelson 5936), Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: mineral soil on limestone, Bighorn Natl Forest, T57N, R89W, Sect. 27, 16 Jun 1992, *McKee 92–025,* c.fr., dehisced, teeth uneroded, with *Ditrichum flexicaule* (BUF, RM,). Teton Co: on humus in deep shade under shrubs along Jenny Lake Trail, W shore of Jenny Lake, 7000 ft, 5 Aug 1974, *Hermann 25766* (sterile) (RM). Yellowstone Natl Park: 7 Jul 1934, *Frye s.n.* (RM); open lodgepole pine woods, 8000 ft, 4 mi NW of Fishing Bridge, 18 Jul 1965, *Hermann 20020* (sterile) (RM); Firehole River, near Old Faithful Geyser, on soil, 6 Jul 1934, *Frye s.n.,* the leaves are well toothed, long and slender (RM); along Firehole River, Old Faithful, 4 Sep 1948, *Conard 48–262* (YELLO).



Courtesy FNA Association, FNA 27, 2007

Dicranum spadiceum Zett., Kongl. Svenska Vetensk. Acad. Handl. 5(10): 20. 1865.
Dicranum angustum Lindb.
Dicranum laevidens R.S. Williams
Dicranum muehlenbeckii var. *neglectum* (De Not.) Pfeff.
Dicranum neglectum Jur. ex De Not.

Wyoming (FNA Vol. 27, 2007). Wyoming; Alaska, Yukon; Labrador, Quebec. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010). (As *Dicranum neglectum* Juratz.) Yancey's, Yellowstone Natl Park (Nelson & Nelson 5936), Porter (1935). Wyoming, Flowers (1973).

Park Co.: Beartooth Plateau, 2900 m, *Weber B–44241* (COLO, RM). Yellowstone Natl Park: 17 Jul 1899, *Nelson & Nelson s.n.* (RM); Lost Lake, 17 Aug 1953, *Lawton 1833* (det. as *D. fuscescens*) (YELLO).

This species, in areolation, resembles a broader *Dicranum elongatum*.

Dicranum tauricum Sapjegin, Bot. Jahrb. Syst. 46: 10. 1911.

Dicranum strictum Schleich. ex D. Mohr, illeg.
Orthodicranum strictum (Mohr) Broth.

Wyoming (FNA Vol. 27, 2007). Throughout the Pacific Northwest; Alaska, California, Colorado, Saskatchewan. Wyoming, Flowers (1973). (As *Dicranum strictum* Schleich.) Tower Falls, Yellowstone Natl Park (collector unknown), Porter (1935). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Crook Co.: Black Hills: Bear Lodge Mts., along Beaver Creek, 6.4 km NNE of Warrens Peak, conifer woods; moss partly shaded, on decaying *Pinus ponderosa* log, *Churchill 8748* (BUF), Exsiccat 13 Musci Planitiebus Incolae 1987. Yellowstone Natl Park: Tower Junction, *Hermann 25768* (RM).

DIDYMODON Hedw., Sp. Musc. Frond., 104. 1801. (Pottiaceae)
Geheebia Schimp.
Trichostomopsis Card.

Didymodon asperifolius (Mitt.) H.A. Crum, Steere & L.E. Anderson, Bryologist 67: 163. 1964.
Barbula asperifolia Mitt., J. Proc. Linn. Soc., Bot., suppl. 1: 34. 1859.
Didymodon rufus Lorentz

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co: 3250 m, *Weber B–44226* (RM, COLO)..

Didymodon fallax (Hedw.) R.H. Zander, Phytologia 41: 28. 1978.
Barbula fallax Hedw., Sp. Musc. Frond., 120. 1801.
Barbula ferruginea Schimp. ex Besch.
Triquetrella ferruginea (Schimp. ex Besch.) Thér.

Wyoming (FNA Vol. 27, 2007).

Sheridan Co.: Mineral soil on limestone outcrop, Big Horn Natl Forest, T57N, R89W, Sect. 28, with *Distichium capillaceum* and *Mnium blyttii,* 17 Jun 1992, *McKee 92–030* (RM).

Didymodon ferrugineus (Schimp. ex Besch.) M.O. Hill, J. Bryol. 11: 599. 1982.
Barbula ferruginea Schimp. ex Besch., Mém. Soc. Natl. Sci. Nat. Cherbourg 16: 181. 1872.
Barbula reflexa (Brid.) Brid.
Didymodon fallax var. *reflexus* (Brid.) R.H. Zander
Didymodon rigidicaulis (Müll. Hal.) K. Saito

Not reported for Wyoming in FNA (FNA Vol. 27, 2007).

(As *D. fallax* var. *reflexus* (Brid.) Zander) Crum & Anderson 1981: 342 mention a report from Wyoming.

[*Didymodon luridus* Sprengel, excluded]

(See Zander 1978) "does not occur in the flora area, though reported from there by many authors (often as *D. trifarius*, see Zander 1981" (Zander, FNA 2007). (As *Didymodon trifarius*) Weston Co., Wynne (1943).

Didymodon nicholsonii Culmann, Rev. Bryol. 34: 100, figs. 1–9. 1907 (as nicholsoni).
Didymodon vinealis var. *nicholsonii* (Culmann) R.H. Zander

Not reported for Wyoming FNA (FNA Vol. 27, 2007).

Park Co.: 6500 ft, *Hermann 20033* (RM).

Didymodon rigidulus Hedw., Sp. Musc. Frond., 104. 1801 (as rigidulum).
Barbula rigidula (Hedw.) Milde

Var. **rigidulus**
Barbula waghornei Kindb.
Didymodon fuscoviridis Card.

Wyoming (FNA Vol. 27, 2007). (As *Barbula rigidulus* (Hedw.) Mitt.) Limestone rocks, Telephone Canyon, Albany Co. (*Porter 1278*), Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: hanging underneath a ledge with dripping water from limestone seep, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 34, 16 Jun 1992, *McKee 92–010,* with propagula, with *D. rigidulus* var. *icmadophilus* intermixed (BUF).

Var. **gracilis** (Schleicher ex Hook. & Grev.) R.H. Zander, Cryptog. Bryol. Lichénol. 2: 393. 1981.
Tortula gracilis Schleicher ex Hook. & Grev., Edinburgh J. Sci. 1: 300. 1824.
Barbula acuta (Brid.) Brid.
Didymodon acutus (Brid.) K. Saito

Wyoming (FNA Vol. 27, 2007).

Albany Co.: 7415 ft, limestone rock, full sunlight, 19 Mar 1988, *Vukelich s.n.* (BUF); forming dense cushions on limestone rocks, Telephone Canyon, 25 Nov 1932, *Porter 1278* (NY). Crooke Co.: *Eckel 219686* (RM, BUF). Fremont Co.: big spring about 4 mi east of Dubois, 23 Jun 1931, *Frye s.n.* (WTU). Sheridan Co.: in crevices of rock ridge faces, limestone, Big Horn Natl Forest, T57N, R89W Sect. 15, 24 Jun 1992, *McKee 92-048* (RM).

See also discussion sub var. *icmadophilus*.

Var. **icmadolphilus** (Schimp. ex Müll. Hal.) R.H. Zander, Cryptog. Bryol. Lichénol. 2: 394. 1981.
Barbula icmadophila Schimp. ex Müll. Hal., Syn. Musc. Frond. 1: 614. 1849.
Barbula acuta ssp. *icmadophila* (Schimp. ex c. m) Podp.
Barbula acuta var.*icmadophila* (Schimp. ex Müll. Hal.) H.A. Crum;
Barbula gracilis ssp. *icmadophila* (Schimp. ex Müll. Hal.) Amann
Didymodon acutus var. *icmadophilus* (Schimp. ex Müll. Hal.) R.H. Zander
Didymodon icmadophilus (Schimp. ex Müll. Hal.) Saito (as "icmadophyllus").
Tortula icmadophila (Schimp. ex Müll. Hal.) Lindb.

This variety was not reported for Wyoming by FNA (FNA Vol. 27, 2007).

Sheridan Co.: hanging underneath a ledge with dripping water from limestone seep, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 34, Jun 16 1992, *McKee 92–010* (BUF), with *D. rigidulus* var. *rigidulus* (propaguliferous) intermixed.

The above specimen has the characteristic attenuated fleshy apices and reduced upper lamina. The varieties intergrade. Note that var. *icmadophilus* is generally longer in both leaf and acumen than *gracilis* (see Zander, Cryptogamie). A specimen from the Loess Hills of Iowa is also papillose.

Didymodon tophaceus (Brid.) Lisa, Elenc. Musch., 31. 1837.
Trichostomum tophaceum Brid., Muscol. Recent., suppl. 4: 84. 1818.
Barbula pringlei (Card.) Hilp.
Barbula tophacea (Brid.) Mitt.
Dactylhymenium pringlei Card.
Desmatodon hendersonii (Ren. & Card.) R S. Williams
Husnotiella pringlei (Card.) Grout

Wyoming (FNA Vol. 27, 2007).

Didymodon umbrosus (Müll. Hal.) R.H. Zander, Phytologia 41: 22. 1978.
Barbula umbrosa Müll. Hal., Linnaea 42: 340. 1879.
Didymodon australasiae var. *umbrosus* (Muller Hal.) R.H. Zander
Trichostomopsis crispifolia Card.
Trichostomopsis umbrosa (Müll. Hal.) H. Robinson

This species was not reported for Wyoming by FNA (FNA Vol. 27, 2007), although a duplicate of the following specimen existed at BUF indicated the author of the FNA treatment had verified it, even though the record did not end up in the FNA.

Sublette Co.: South Fork of Baldy Creek headwaters, 10,290 ft, on damp rock at edge of fen, 42°59'N, 109°34'W, 16 Aug 1989, *Andrus 7833a* (BING, BUF).

Didymodon vinealis (Brid.) R.H. Zander, Phytologia 41: 25. 1978.
Barbula vinealis Brid., Bryol. Univ. 1: 830. 1827.

Var. **vinealis**
Barbula bakeri Card. & Thériot
Barbula circinnulata Müll. Hal. & Kindb.
Barbula cylindrica (Taylor) Schimp.
Barbula. flexifolia Hampe
Barbula horridifolia Müll. Hal. & Kindb.
Barbula laterita Kindb.
Barbula pseudorigidula Müll. Hal. & Kindb.
Barbula robustifolia Müll. Hal. & Kindb.
Barbula semitorta Sull.
Barbula subcylindrica Broth.
Barbula subgracilis Müll. Hal. & Kindb.
Barbula tortellifolia Müll. Hal. & Kindb.
Barbula treleasei Card. & Thériot
Barbula vinealis var. *flaccida* P. Bruch & Schimp.
Barbula virescens Lesq.
Didymodon vinealis var. *flaccidus* (P. Bruch & Schimp.) R.H. Zander

Wyoming (FNA Vol. 27, 2007).

Sheridan Co. 6600–8000 ft, *Odasz 1145* (RM, BUF). Washakie Co.: Tensleep Canyon, willow roots, streamside, 24 Jul 1980, *Zander s.n.* (BUF). Weston Co.: dryish hill, on ground, with *Desmatodon obtusifolius*, *Bryoerythrophyllum recurvirostrum*, 16 Jul 1942, *Degener & Peiler s.n.* (NY). (as var. *flaccidus*). Sheridan Co.: on vertical rock face, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 27, with *Homalothecium, Bryoerythrophyllum recurvirostrum, Fissidens bryoides, Platydictya jungermannioides, Distichium capillaceum*, *McKee 92–024* (BUF). Yellowstone Natl Park: shore of Yellowstone Lake near West Thumb, limestone, 23 Jul 1980, *Zander s.n.* (BUF).

Var. **rubiginosus** (Mitt.) R.H. Zander, Cryptog. Bryol. Lichénol. 2: 417. 1981.
Barbula rubiginosa Mitt., J. Linn. Soc., Bot. 8: 27, fig. 5. 1865.
Barbula melanocarpa Kindb.
Barbula subicmadophila Kindb.
Didymodon occidentalis R.H. Zander
Racomitrium cyclodictyon Card. & Thériot

Not reported for Wyoming by FNA (FNA Vol. 27, 2007), but no doubt overlooked at BUF.

Teton Co.: at Hwy. 22, Burbank Creek 6 mi SE of Victor, *Pinus-Pseudotsuga*-forests, primitive rocks about 2260 m on rock at creek border, *Duell 2238/2* (BUF).

DISTICHIUM P. Bruch & Schimp., Bryol. Europ. 2: 153. 1846. (Ditrichaceae)

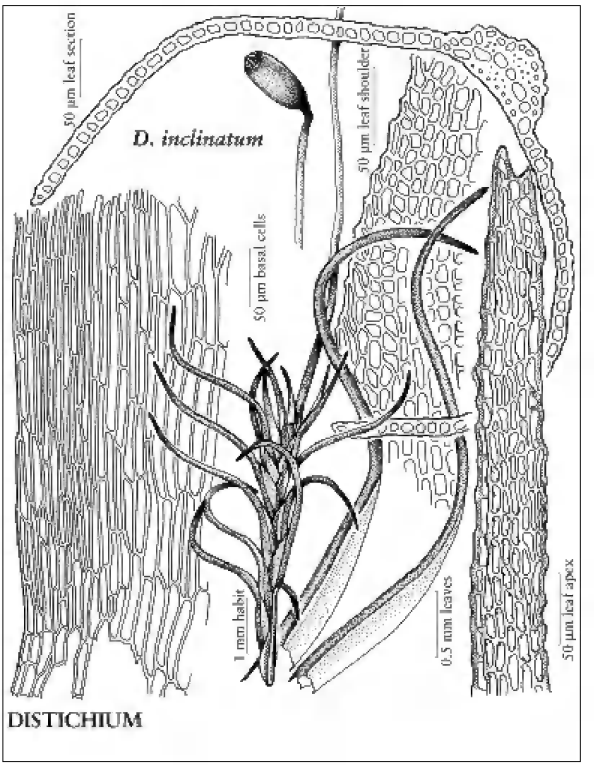
Distichum capillaceum (Hedw.) P. Bruch & Schimp., Bryol. Europ. 2: 156. 1846.
Cynontodium capillaceum Hedw., Sp. Musc. Frond., 57. 1801.
Swartzia montana Lindb.

Wyoming (FNA Vol. 27, 2007). Throughout the Pacific Northwest; Alaska, California, Nevada, Utah, Colorado, Arizona; Manitoba, Minnesota, Michigan; Greenland and Nova Scotia to New England and New York. (As *Swartzia montana*) Rather common throughout the State, especially in limestone regions. Albany, Carbon, Johnson, Sheridan, Sublette, Teton cos., Yellowstone Natl Park, Porter (1937). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, Spence (1981). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co: Medicine Bow Mountains, W of Centennial, Pole Mountain Division (Sheridan Mountains), WY 130, near the Snowy Range Pass, granite rocks, partial shade, 5 Aug 1984, *Eckel 871107* (BUF). Big Horn Co: T49N R 87W S25, Big Horn Mountains, ca. 1 air mi SW of Tyrrell Ranger Station, Sect. 25 & 36, E-facing slope, 8800 ft, 21 Jun 1979, *Hartman & Odasz 9146* (RM). Johnson Co.: 6600 ft, *B. Nelson 6836c* (RM). Park Co.: wet soil in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 19 Apr 1992, *Elliott 1935* (BUF). Sheridan Co: Big Horn Mtns., Ice Creek, ca. 8.5 air mi WNW of Burgess Junction, openings in valley and on slopes, 8800 ft, 23 Jun 1979, *Hartman & Odasz 9248* (RM). Sublette Co.: 10,348 ft, *Rolston 85115* (CSU). Teton Co: on US 26 & US 237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus,* asters, wooded stream, soggy debris, c.fr., 6 Jul 1985, *Eckel 94082101* (BUF, RM). Washakie Co.: 8000 ft, *Nelson & Fonken 7316* (RM, BUF). Yellowstone Natl Park: grassy seep, swale, roots of *Salix*, 6239 ft, a few miles from Mammoth Hot Springs on Road to Tower, with *Aulacomnium palustre,*

Amblystegium juratz., Bryoerythrophyllum recurvirostrum, Bryum pseudotriquetrum var. *bimum, Brachythecium frigidum, Drepanocladus aduncus, D. uncinatus, Leptobryum pyriforme, Plagiomnium rugicum, Plagiothecium denticulatum,* 6 Jul 1995, *Eckel 95082828* (BUF),

Without fruit, this may be confused with *Leptobryum pyriforme*: both have long, setaceous leaves. There is a var. *curvatum* Flow. in 1990 checklist (= same capsule but curved—banana shaped.)



Courtesy FNA Association, FNA 27, 2007

Distichum inclinatum (Hedw.) P. Bruch & Schimp., Bryol. Europ. 2: 157. 1846.
Cynontodium inclinatum Hedw., Sp. Musc. Frond., 58. 1801.
Swartzia inclinata Hedw.

Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park, (*1447*) (Roell 1893). British Columbia, Alberta, Montana, Wyoming; Yukon, Northwest Territory, California, Nevada, Utah, Colorado; Minnesota, Ontario; Greenland, Quebec, and New England. (As *Swartzia inclinata* Hedw.) Mammoth Hot Springs, Yellowstone Natl Park (*Nelson 6026*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: NW base of Sheep Mtn, along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula* and *Salix* dominant, 7 Jun 1993, *Buck 23246,* c.fr., (NY). Fremont Co.: *Hermann 25309* (RM).

Buck's specimen conforms well to Flower's (1973) description. As compared to its congener, the stems are indeed darker, as are the capsules, as though the plant was smudged; the capsules are inclined from the juncture with the seta and asymmetrical. The setae are red-purple at the base and red to red-orange above. The peristome segments are strikingly broad.

DITRICHUM Hampe, Flora 50: 181. 1867, name conserved. (Ditrichaceae)

Ditrichum flexicaule (Schwägr.) Hampe, Flora 50: 182. 1867.
Cynodontium flexicaule Schwägr., Sp. Musc. Frond. Suppl. 1(1): 113, plate 29. 1811.
Leptotrichum flexicaule Hampe

Wyoming (FNA Vol. 27, 2007). (As *Leptotrichum flexicaule*) In the spray of the falls, Tower Falls, Yellowstone Natl Park (*Nelson 3549*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: mineral soil on limestone, Bighorn Natl Forest, T57N, R89W, Sect. 27, 16 Jun 1992, *McKee 92–025* (BUF, RM) with *Dicranum scoparium.* Yellowstone Natl Park: *Nelson & Nelson 5912* (RM).

Ditrichum gracile (Mitt.) Kuntze, Revis. Gen. Pl. 2: 835. 1891.
Leptotrichum gracile Mitt., Hook.'s J. Bot. Kew Gard. Misc. 3: 353. 1851.
Ditrichum crispatissimum (Müll. Hal.) Paris
Ditrichum giganteum R.S. Williams
Leptotrichum crispatissimum Müll. Hal.

Wyoming (FNA Vol. 27, 2007).

DREPANOCLADUS (Müll. Hal.) G. Roth, Hedwigia 38(Beibl.): 6. 1899, name conserved. (Amblystegiaceae)
Hypnum subsect. *Drepanocladus* Müll. Hal., Syn. Musc. Frond. 2: 321. 1851; *Calliergidium* (Ren.) Grout

Drepanocladus aduncus (Hedw.) Warnst., Beih. Bot. Centralbl. 13: 400. 1903.
Hypnum aduncum Hedw., Sp. Musc. Frond., 295. 1801.
Brachythecium edentatum R.S. Williams
Calliergidium bakeri (Ren.) Grout
Drepanocladus aduncus var. *kneiffii* (Schimp.) Mönk.
Drepanocladus aduncus var. *polycarpus* (Voit) G. Roth
Drepanocladus aduncus var. *pseudofluitans* (Sanio) Głowacki
Drepanocladus kneiffii (Schimp.) Warnst.
Drepanocladus simplicissimus Warnst.
Drepanocladus stagnatus Żarnowiec

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (1567, 1579) (Roell 1893); Yellowstone Natl Park, Deer Lodge (1418) (Roell 1893); as var. *kneiffii* Sch. Yellowstone

Natl Park (1561a, 1577a) (Roell 1893); Yellowstone Natl Park (*1547*) (Roell 1893); var. pungens (H. Müll. (sic)) Yellowstone Park (1576) (Roell 1893); var. laxum Sch. Yellowstone Natl Park (*1577a, 1578a*) (Roell 1893: 274). Albany County, Carbon County, Lincoln County, Sheridan County, Sublette County, Teton County, Uinta County, and Yellowstone Natl Park. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

"The following varieties and forms have been recorded: var. *aquaticus* forma *capillifolius*; var. *polycarpus* formae *gracilescens* and *filicuspis*; and var. *Kneiffii*, Porter (1935). Sublette Co.: "Species occupying peatland expanses and spring fens ... tolerant of long periods of saturation and submersion," Cooper & Andrus (1994). Albany, Lincoln, Sublette, Teton, Unita Cos., Yellowstone Natl Park, Porter (1937). Lawton. Teton Co., Spence (1985).

Albany Co.; 10,000 ft, leaf mold, *Hermann 17693 1/2* (RM); NW base of Sheep Mtn., seep area (calcarous fen) with *Populus, Betula,* and *Salix*, *Buck 23244* (NY). Big Horn Co.: Big Horn Natl. Forest, Lake Solitude Quad., Cloud Peak Wilderness area, 9840 ft, filled-in lake, 5 Aug 1992, *Zacharkevics s.n.* (BING). Fremont Co.: 8400 ft, *Hermann 25525* (RM). Johnson Co.: Big Horn Natl Forest, Cloud Peak Quadrant, Cloud Peak Wilderness Area, 10,800 ft, T51N R85W, Sect. 18., 23 Jul 1992, *Zacharkevics s.n.* (BING). Laramie Co.: *Hermann 25920* (RM). Lincoln Co.: moist open willow flat along Fire Trail Creek at Greys River, 6400 ft, Salt River Range, 8 mi E of Alpine Junction, *Hermann 25587* (RM). Park Co.: 7500 ft, *Hermann 20048* (RM); wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 19 Apr 1992, *Elliott 1928* (BUF). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May 1989, *Andrus 7799* (BING). Teton Co.: on US 26 & US 237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, 6 Jul 1985, *Eckel 94082108* (BUF). Yellowstone Natl Park: grassy seep, swale, roots of *Salix*, 6,239 ft, a few miles from Mammoth Hot Springs on Road to Tower, with *Aulacomnium palustre, Amblystegium juratz., Brachythecium frigidum, Bryum pseudotriquetrum* var. *bimum, Distichium capillaceum, Bryoerythrophyllum recurvirostrum* & *Saonia uncinatus, Leptobryum pyriforme, Plagiomnium rugicum, Plagiothecium denticulatum*, 6 Jul 1995, *Eckel 95082829* (BUF).

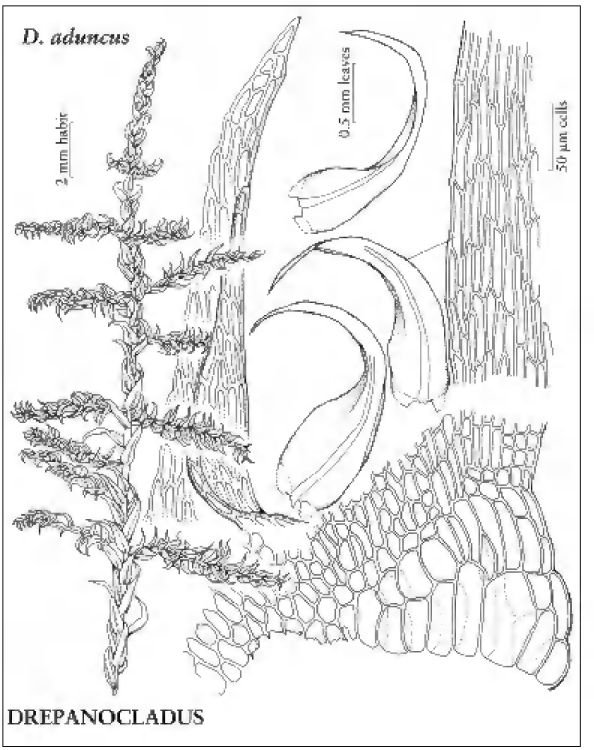
The alar cells of this species are described as hyaline and thin. *Drepanocladus exannulatus* has alar cell walls yellow or brown, thin or slightly thickened. I find *D. aduncus* soft with leaves easily coming off, whereas *D. exannulatus* is coarse with alar regions often staying on the stem.

(As var. *kneiffii* (Schimp. in B.S.G.) Mönk.) County?: Little Laramie River, *Nelson 4294* (RM). Albany Co.: NW base of Sheep Mtn., along WY Rte. 11, ca. 4 mi due ESE of Centennial, ca. 7750 ft, fen with low forest of *Populus, Betula, Salix,* in shallow water, a "hanging bog" on steep hillside, wet rotting log, 7 Jun 1993, *Reese 18176* (LAF, BUF, RM). Big Horn Co.: Big Horn Natl Forest, Lake Solitude Quadrant, T50N R87W, Sect. 12, 9600 ft, 5 Aug 1992, *Zacharkevics s.n.* (BING). Lincoln Co.: Cokeville, 11 Jun 1898, *Nelson 4626* (RM). Uinta Co.: Fort Bridger, 9 Jun 1898, *Nelson 4609* (RM).

The leaves lie flat and the inflations seem gradual, not abrupt, as in var. *polycarpus*. The leaves are straight, falcate-secund in var. *polycarpus*. Care must be had here not to confuse this species with *Cratoneuron filicinum*, which has a stouter, longer costa and whose cells are short and thick as in *Amblystegium* with serrated leaf margins. Also one might want to suppose this plant a *Brachythecium*, such as *B. nelsonii* (concave leaf bases) or *B. starkei* (serrated margins): var. *kneiffii* is flat, entirely smooth leaf margins and with short cells. "The studied two isosyntypes of *Hypnum kneiffii* var. *filiforme* S. Berggren consist of the species *Drepanocladus aduncus*, and *D. sordidus* and *Scorpidium cossonii* " (Hedenäs in FNA Vol. 28, 2014).

(As var. *polycarpus* (Bland. ex Voit) Roth): Albany Co.: ca. 4 air mi ESE of Centennial, NW base of Sheep Mountain along WY 11, 7700–7900 ft, *Populus, Betula*, and *Salix* associated with spring seep, open fen, 7 Jun 1993, *Miller 10,271* (NYS). Park Co.: 3200 m, *Weber B–44314* (RM, COLO). Yellowstone Natl Park: along Firehole River near Old Faithful; border of mudpot, 6 Jul 1934, *Frye s.n.* (RM); in Gibbon Canyon, *Nelson 6747a* (RM); Yancey's, in a bog, 16 Jul 1899, *Nelson & Nelson 5903* (RM), note by Porter of Grout det. as this variety.

"Because *Drepanocladus aduncus* is variable in habit, several taxa have been segregated from this species. The phenotypes most frequently recognized at the species level were small plants with short laminal cells and weak costae called *D. polycarpus*" (Hedenäs in FNA Vol. 28, 2014). There is sometimes confusion with *Cratoneuron*, which is rarely if ever without teeth on the margin.



Courtesy FNA Association, FNA 28, 2014

Drepanocladus capillifolius (Warnst.) Warnst. = Drepanocladus longifolius (Wilson ex Mitt.) Broth. ex Paris

Drepanocladus crassicostatus Janssens = Drepanocladus longifolius (Wilson ex Mitt.) Broth. ex Paris

Drepanocladus exannulatus (Schimp. in B.S.G.) Warnst. = Sarmentypnum exannulatum (Schimp.) Hedenäs

Drepanocladus fluitans (Hedw.) Warnst. = Warnstorfia fluitans (Hedw.) Loeske

Drepanocladus longifolius (Wilson ex Mitt.) Broth. ex Paris, Coll. Nom. Broth., 10. 1909.
Amblystegium longifolium Wilson ex Mitt., J. Linn. Soc., Bot. 12: 571. 1869.
Drepanocladus aduncus var. *capillifolius* (Warnst.) Riehmer
Drepanocladus capillifolius (Warnst.) Warnst.
Drepanocladus crassicostatus Janssens

Wyoming (FNAVol. 28, 2014). (As *Drepanocladus capillifolius*) Two stations in southern Wyoming are reported by Janssens (1983). (As *Drepanocladus crassicostatus*) "Yellowstone Natl Park, Lost Lake, Welch 16387 (CANM)" Janssens (1983). Lost Lake and tributaries, in puddle, shore of Lost Lake, Welch 16387 (CANM) Aug 17 1953. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Drepanocladus capillifolius*) Carbon Co.: Wagon Hound Creek, 21 Aug 1897, *Nelson 4262,* with thick walled auricular cells, a robust plant all over and capillifoliaceous leaves (RM). Sheridan Co.: Dome Lake, 16 Jul 1896, *Nelson 2408* (RM).

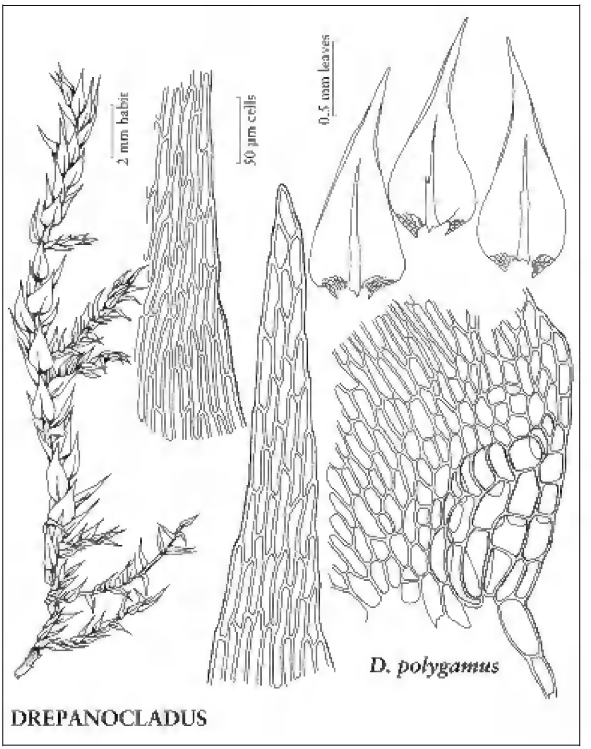
The tips of the Welch specimen were brush like, collected into a tuft, but the tuft was curled, as were the leaves, not erect. The costa was very wide in leaves of the main stem "often occupying 1/3 to 1/2 of the leaf base. The alar cells are not as well differentiated as in other species of the genus (from Janssens 1983).

Drepanocladus revolvens (Sw.) Warnst. = Scorpidium revolvens (Sw.) Rubers

Drepanocladus polygamus (Schimp.) Hedenäs, Bryologist 100: 82. 1997.
Amblystegium polygamum Schimp. in Bruch & Schimper, Bryol. Europ. 6: 60, plate 572. 1853.
Campyliadelphus polygamus (Schimp.) Kanda
Campylium polygamum (Schimp.) C.E.O. Jensen
Campylium polygamum var. *fluitans* Grout
Campylium polygamum var. *minus* (Schimp.) G. Roth

Wyoming (FNA Vol. 28, 2014). (As *Hypnum polygamum* var. *fallaciosum* (Jur.) Ren. & Card. (*Hypnum fallax* Jur.) Wyoming: Yellowstone Natl Park (*1566*) (Roell 1893). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 10,000 ft, *Hermann 17691* (RM).



Courtesy FNA Association, FNA 28, 2014

[*Drepanocladus sendtneri* (Schimp.) Warnst. (Amblystegiaceae) excluded]
Drepanocladus sendtneri var. *wilsonii* (Lindb.) Warnst.

This species has apparently been excluded from North America (early version of FNA Vol. 28, 2014); see Crum and Anderson (1981) citation below. "Because the species of the *Drepanocladus sendtneri* (Schimp. ex H. Müll.) Warnst. and *D. aduncus* complexes have only recently been understood, the North American distribution of *D. sordidus* is at present likely to be incompletely known. The Eurasian and African *D. sendtneri* is a species of strongly calcareous areas, where it usually grows in shallow fens or in periodically wet depressions. It is most safely distinguished from *D. sordidus* by a different ratio of median leaf lamina cell length (µm) to leaf length (mm), between 17.9–24.4 (between 23.3–36.5 in *D. sordidus*). Although no examined specimens originally identified as *D. sendtneri* from North America have turned out to belong to this species, it may still be premature to completely exclude the possibility that this otherwise widespread species occurs also on this continent" (Hedenäs, an earlier version of FNA Vol. 28, 2014).

Evanston, Uinta County (Nelson 8125), Porter (1935). Unita Co., Porter (1937).

Possible specimens of *D. sendtnerii*:) Uinta Co.: Evanston, submerged in a pool, Plants of Wyoming exsiccat, *Nelson 8125* (RM). Sublette Co.: Bridger Wilderness, Wind River Range *Carex*

fen S of Timico Lake, 18 May 1989, *Andrus 7894* (median cells porose) (BING). Yellowstone Natl. Park: Fountain Geyser, 29 Aug 1951, *Lawton 1511* (by reason of the alar cells thick walled, costa stout) (YELLO); Lost Lake outlet, 1 Sep 1948, *Conard 48-227* (YELLO).

Mentioned by Lawton (1971). Crum and Anderson (1981: 963) lumped this with *D. aduncus* (Hedw.) Warnst.

Drepanocladus uncinatus (Hedw.) Warnst. = Sanionia uncinata (Hedw.) Loeske

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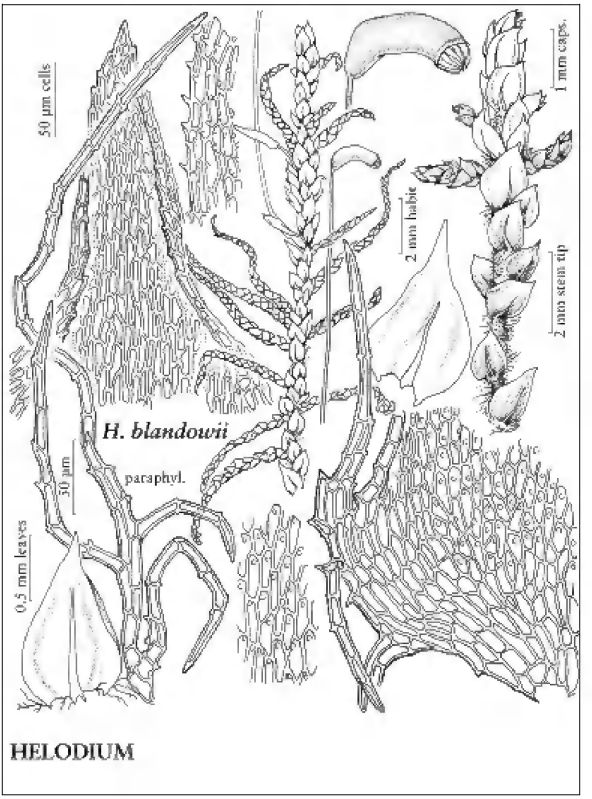
ELODIUM (Sull.) Aust., Musci Appalach., 52. 1870. (Helodiaceae)

Hypnum sect. *Elodium* Sull. in A. Gray, Manual ed. 2, 668. 1856; *Helodium* Warnst., name conserved.



Courtesy FNA Association, FNA 28, 2014

Elodium blandowii (F. Weber & D. Mohr) Eckel, Phytoneuron 2012–70: 6. 2012.

Hypnum blandowii F. Weber & D. Mohr, Bot. Taschenbuch, 332. 1807 (as blandovii).

Helodium blandowii (F. Weber & D. Mohr) Warnst.

Helodium lanatum (Brid.) Broth.
Hypnum lanatum Brid.
Leskea blandowii (F. Weber & D. Mohr) Mitt.
Thuidium blandowii (F. Weber & D. Mohr) Schimp.

In Park Co. *Elodium blandowii,* forms a rich bryophyte community combined with *Aulacomnium palustre*, *Climacium dendroides*, *Hylocomium splendens, Helodium blandowii, Rhizomnium* spp., *Marchantia alpestris*, (*Thuidium recognitum*, q.v.) and others" (Kosovich-Anderson & Weber 2011). (As *Helodium lanatum* (Brid.) Broth.) Albany Co. (Nelson *1746* & *2700*; Porter *935* & *1441*), Porter (1935). (As *Thuidium blandowii*) Yellowstone Natl Park: a specimen was noted by Roell (1893) for Yellowstone (number 1531). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Centennial Valley, 19 Aug 1895, *Nelson s.n.* (RM); Centennial Hills, *Nelson 2700* (RM). Yellowstone Natl Park: 1 Sep 1948, *Conard 48–232* BUF.

ENCALYPTA Hedw., Sp. Musc. Frond., 60. 1801. (Encalyptaceae)

[*Encalypta alpina* Smith in J.E. Smith et al., Engl. Bot. 20: 1419. 1805, excluded.]

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). Albany Co.: Porter (1937).

Horton (l983), in a distribution map for this species, gives no reference to occurrences in Wyoming. *Encalypta alpine* seems therefore to be disjunct from Alberta to Colorado.

Encalypta ciliata Hedw., Sp. Musc. Frond., 61. 1801.
Encalypta alaskana Kindb. in Macoun
Encalypta ciliata var. *microstoma* Schimp.
Encalypta laciniata Lindb.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest; Alaska, California, Arizona, Colorado; South Dakota, Iowa, Minnesota, Wisconsin, Michigan, Ontario; Nova Scotia. Crook Co., Porter (1937). Several localities in central Wyoming are indicated on a dot map by Horton l983 (montane).

[*Encalypta contorta* Hoppe ex Lindb. = *E. streptocarpa* Hedw., an Old World species, excluded from North America by Anderson et al. 1990; confirmed by Magill (FNA Vol. 28 2014).]

Albany County (*Porter 675*), Porter (1935); perhaps a specimen of *Encalypta procera*, which strongly resembles *E. streptocarpa*.)

Encalypta procera Bruch, Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 1: 283. 1832.
Encalypta streptocarpa sensu American authors (see Crum & Anderson 1981: 265).

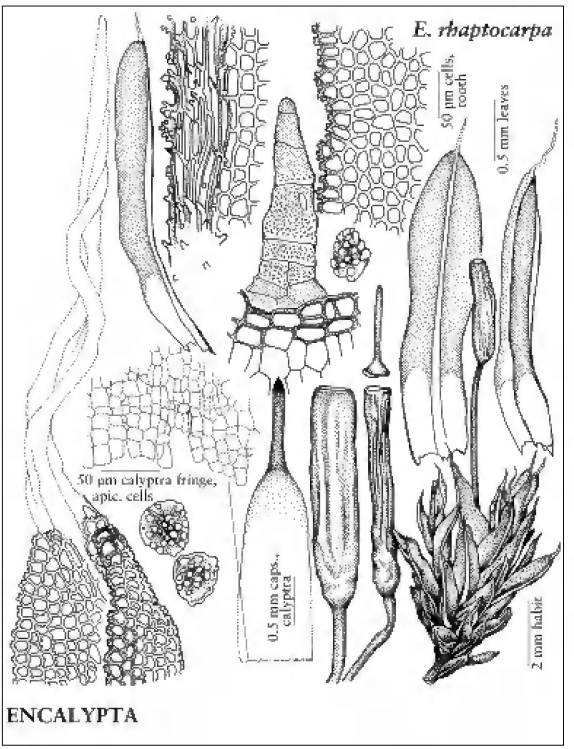
Wyoming (FNA Vol. 27, 2007). Horton (l983) on a dot-distribution map gives a literature report for Wyoming but with two dots on state boundaries so that the state in which the reported occurrence lies is ambiguous. (As *Encalypta streptocarpa* Hedw.) Albany Co., Porter (1937).

Encalypta rhaptocarpa Schwägr., Sp. Musc. Frond. Suppl. 1(1): 56. 1811.
Encalypta intermedia Juratzka
Encalypta rhaptocarpa Schwägr.

Encalypta rhaptocarpa var. *microstoma* Limpr.
Encalypta rhaptocarpa var. *subspathulata* (Müll. Hal. & Kindb.) Flowers
Encalypta subspathulata Müll. Hal. & Kindb. in Macoun
Encalypta vulgaris var. *rhaptocarpa* (Schwägr.) Lawton

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest; Alaska, Yukon, California, Nevada, Colorado; South Dakota. (As *Encalypta rhaptocarpa* Schwaeg.) Albany County (*Porter 694*), Carbon (*Goodding 75*), (Sheridan Co.) Porter (1935). (As *E. rhaptocarpa*) Uinta Co., "has been collected by Nelson in Albany and Carbon Counties," Wynne (1943). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Laramie Mountains, Roger Canyon, 7 air mi NE of Laramie city center, limestone outcrops with *Cerocarpus montanus, Artemisia cava, A. tripartita, A. nova, A. tridentata*, on soil below rock outcrop, 7 Jun 1993, *Miller 10,233* (NYS). Fremont Co.: Bridger-Teton Natl. Forest on US 26 & US 287, between Moran & Dubois, ca. 9000 ft, alpine meadow, much herbage, wet with flowing streams, granite outcrops, N slopes of low knoll, c.fr., with *Tortula ruralis*, *Eckel 93081101* (BUF). Park Co.: soil in crevice of granite outcrop along Crandall Creek, Shoshone Natl. Forest, 36 mi NW of Cody, 6500 ft *Hermann 20039* (RM). Sublette Co.: 7950 ft, *Hermann 25340* (RM).



Courtesy FNA Association, FNA 27, 2007

Encalypta spathulata Müll. Hal., Syn. Musc. Frond. 1: 519. 1849.

Wyoming (FNA Vol. 27, 2007). "*Encalypta spathulata* is very similar to *E. rhaptocarpa* but differs in the fringed calyptra base and weakly striate, eperistomate capsule. The gymnostomous capsules and long awn will separate *E. spathulata* from other species of the genus" (Magill, FNA Vol. 27, 2007).

Encalypta vulgaris Hedw., Sp. Musc. Frond., 60. 1801.
Encalypta vulgaris var. *apiculata* Wahlenb.
Encalypta vulgaris var. *mutica* Brid.

Wyoming (FNA Vol. 27, 2007). (As *Encalpyta extintoria* (L.) Sw. (= *Encalypta vulgaris* Hedw. cf. Hedw., Spec. Musc. 60. 1801. Index Muscorum). " The plants so far found all belong in var. *mutica* Brid. Plumbago Canyon, Telephone Canyon, both in Albany County, Porter (1935).) In all states and provinces of the Pacific Northwest; California, Nevada, Utah, New Mexico, Colorado; Saskatchewan, Manitoba. (As Encalypta vulgaris Hedw.) Albany Co., Porter (1937). (As *E. vulgaris* var. *mutica* Brid.) Sweetwater Co., "the only other collection of *E. vulgaris* the author has seen from Wy. was collected in the Laramie Mts., (C. L.Porter 796)," Wynne (1943). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Roger Canyon, 8000 ft, *Hermann 17151* (RM); Laramie Mtns., Roger Canyon, ca. 8 air mi NE of Laramie, on Co. Rd. 17, limestone outcrops with *Cercocarpus montanus*, *Buck 23163* (NY). Big Horn Co.: Big Horn Mtns, T49N R 87W S25, ca. 1 air mi SW of Tyrrell Ranger Station; Sect. 25 & 36, E-facing slope, 8800 ft, 21 Jun 1979, *Hartman 9150,* calyptrate, capsules very young (RM). Crooke Co: on WY 585, 0.8 mi N of Weston Co. line, grassland with some *Artemisia* scrub, with *Pterygoneurum ovatum, Tortula ruralis, Didymodon rigidulus* var. *gracilis*, 12 Jul 1985, *Eckel 419686* (BUF, RM). Fremont Co.: 7800 ft, Hermann 25534 (RM). Park Co. 7500 ft, *Hermann 20052* (RM). Sheridan Co.: vertical rock face, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 27, c.fr., 16 Jun 1992, *McKee 92–016,* calyptrate, capsules nearing maturity (BUF, RM). Uinta Co.: Evanston, on dry ground, 8 Jul 1942, *Degener 17074,* c.fr. (in a packet of fruiting *Bryum caespiticium* and filed under that name) (US).

Eurhynchium oreganum (Sull.) A. Jaeg. = Kindbergia oregana (Sull.) Ochyra

Eurhynchium pulchellum (Hedw.) Jenn. = Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen

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EURHYNCHIASTRUM Ignatov & Huttunen, Arctoa 11: 260. 2003 (Brachytheciaceae)

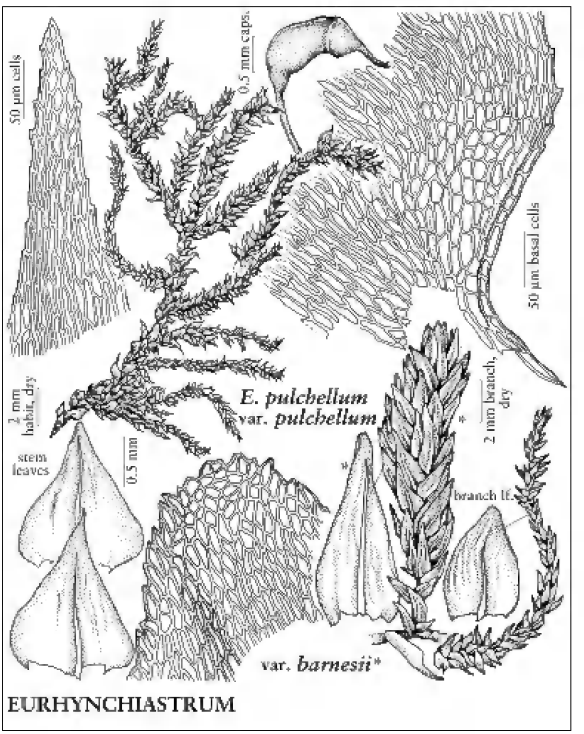
Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen, Arctoa 11: 262. 2003.
Hypnum pulchellum Hedw., Sp. Musc. Frond., 265, plate 68 (top), figs. 1–4. 1801.
Eurhynchium diversifolium B.S.G.
Eurhynchium fallax (Ren. & Card.) Grout
Eurhynchium strigosum (Web. & Mohr) B. S. G.
Eurhynchium strigosum var. *fallax* Ren. & Card.
Eurhynchium strigosum var. *robustum* Roell
Eurhynchium substrigosum Kindb. in Macoun
Hypnum strigosum Web. & Mohr

Var. **pulchellum** or s.l.

(As *Eurhynchium strigosum*) Wyoming: Yellowstone Natl Park (1548, 1549) (Roell 1894). (As *Eurhynchium diversifolium* (Schleich.) B. & S.) Pole Mt., Albany County (Porter 540), Porter (1935). (As *Eurhynchium diversifolium* (Schleich) B. & S.) Albany Co., Porter (1937). Campbell Co., Medina (1994).

Albany Co.: Medicine Bow Mountains, Barber Lake Picnic area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest, on soil, 7 Jun 1993, *Miller 10,258* (NYS). Fremont Co.: *Jozwik 482* (RM). Weston Co.: *Eckel 623686* (RM, BUF). Sublette Co.: Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, sandstone rocks, lush herbage, Hoback River valley, with *Saionia uncinata, Brachythecium salebrosum, Leptodictyum humile, Platydictya jungermannioides,* 5 Jul 1985, *Eckel 9612522* (BUF).

There is a var. *barnesii* (Ren. & Card.) Grout (1990 checklist) as *Eurhynchiastrum pulchellum* var. *barnesii* (Ren. & Card.) Ignatov, but not yet known for Wyoming; its taxonomy is problematic (Ignatov, FNA Vol. 28, 2014). Note form *praecox* is julaceous and resembles *Brachythecium collinum*, also julaceous, by the coarse serrations. The latter, however, has cells in the apices of all leaves that are elongate (greater than 2: 1). *Eurhynchiastrum pulchellum* is more broadly deltoid at the leaf base, *B. collinum* more ovate-lanceolate. The obtuse to broadly acute apices of the branch leaves are more characteristic of *E. pulchellum*.



Courtesy FNA Association, FNA 28, 2014

FISSIDENS Hedw., Sp. Musc. Frond., 152. 1801. (Fissidentaceae)
Moenkemeyera Müll. Hal.; *Octodiceras* Brid.

Fissidens adianthoides Hedw., Sp. Musc. Frond., 157. 1801.
Fissidens adianthoides var. *immarginatus* Lesq. & James

Wyoming (FNA Vol. 27, 2007). On moist soil banks, logs, calcareous and noncalcareous rocks and cliffs. Throughout the Pacific Northwest; Alaska, Northwest Territory, California; Ontario to Labrador and south to Arkansas and Florida. Teton Co., Spence (1985).

Teton Co.: Teton Natl Park, Taggart Lake, 13 Aug 1953, *Lawton 1730* (WTU). Yellowstone Natl Park: Crescent Hill, 17 Aug 1953, *Lawton 1856* (WTU).

Fissidens bryoides Hedw., Sp. Musc. Frond., 153. 1801.
Dicranum viridulum Sw.
Fissidens andersonii Grout
Fissidens bryoides var. *incurvus* (Starke) Hüb.
Fissidens bryoides var. *pusillus* (Wils.) Pursell
Fissidens exiguus Sulliv.
Fissidens exiguus var. *falcatulus* (Ren. & Card.) Grout
Fissidens pusillus (Wils.) Milde
Fissidens synoicous Sulliv.
Fissidens viridulus (Sw.) Wahlenb.
Fissidens viridulus var. *texanus* (Lesq. & James) Grout

Wyoming (FNA Vol. 27, 2007). In shaded areas, commonly on moist soil banks or on soil over logs and rocks, from the lowlands to 2000 m or higher. British Columbia, Washington, Oregon, Idaho, Montana, Wyoming; California; South Dakota, Minnesota; Ontario to Maine and south to Texas and Florida. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: in deep shade on wet, peaty, wooded bank of Nash Fork on Sand Lake Rd., 2 mi NW of Route 130, 8500 ft, Medicine Bow Mts., ca. 4 mi W of Centennial, 5 Aug 1962, c.fr., *Hermann 17774* (RM, WTU). Sheridan Co.: on vertical rock face, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 27, 16 Jun 1992, *McKee 92–024* (RM), c.fr., mature, indehisced, with *Bryoerythrophyllum recurvirostrum, Didymodon vinealis (var. flaccida), Distichium capillaceum, Platydictya jungermannioides*.

Fissidens minutulus Sull., often confused with *F. bryoides*, is a good species, occurring along and east of the Mississippi River (also California); *Fissidens limbatus* is a synonym of *F. crispus* (R. Pursell, pers. comm., Aug 23, 2013). *Fissidens crispus*, with a western distribution, is to be expected in Wyoming.

Fissidens grandifrons Brid., Muscol. Recent., Suppl. 1: 170. 1806.
Pachyfissidens grandifrons (Brid.) Limpr.

Wyoming (FNA Vol. 27, 2007). On limestone, sometimes submerged, in streams, waterfalls, or other wet situations. British Columbia, Washington, Oregon, Idaho, Montana, Wyoming; Alaska, California, Utah, Nevada; Michigan and Ontario to New York, south to Arkansas, Kentucky, Tennessee, and Alabama. Junction of Nez Perces Creek with Firehole River, Yellowstone Natl Park (*Porter 1247*). Very abundant at this locality, Porter (1935).

Sheridan Co.: on rocks in streambed in rapidly flowing water, calcareous region, Dry Fork and Garland Gulch, T57N, R89W, 22 Jun 1992, *McKee 92–043 & 92–044* (BUF, RM). Yellowstone Natl Park: along the Firehole River, on partly submerged rocks in a small stream, 5 Aug 1932, *Porter 1247* (NY, WTU); Black Sand Basin, 18 Aug 1953, *Lawton 1868* (WTU); calcareous rock bed of cascade from large spring along the Firehole River near Madison Junction, Aug 1936, *Drexler 829* (NY); between Madison and Old Faithful, in western exposure, canyon, *Pseudotsuga-Pinus contorta* forest, 2320–2350 m, dripping water, 8 Aug 1981, *Duell 2267/4* (NY).

Fissidens obtusifolius Wilson, London J. Bot. 4: 196, plate 9, fig. b. 1845.
Fissidens obtusifolius var. *kansanus* Ren. & Card.
Fissidens obtusifolius var. *marginatus* Flowers

Not reported for Wyoming in FNA (FNA Vol. 27, 2007).

Albany Co.: Laramie Mts., Roger Canyon, ca. 8 air mi NE of Laramie, 2400 m, limestone outcrops with *Cercocarpus montanus* dominant, *Buck 23160* (NY), with *Bryoerythrophyllum recurvirostrum* and *Didymodon rigidulus* var. *gracilis*.

Apices of the above specimen are too broad for var. *apiculatus* Grout, with variations on the same stem of costa ending to nine cells before the apex. The broad leaves are apiculate, but not broadly acute in all leaves. The intramarginal border in the lower leaves on the vaginant lamina, corresponding to the var. *marginatus* Flow. There are vars. *apiculatus* Grout, var. *kansanus* Ren. & Card. and var. *marginatus* Flow. in the Anderson et al. (1990) checklist.

Fissidens osmundioides Hedw., Sp. Musc. Frond., 153, plate 40, figs. 7–11. 1801.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). Teton Co., Porter (1937). Teton Co., Spence (1985). Johnson Co., in association with *Warnstorfia tundrae* (Lenz 2006). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: W of Bear Tooth Butte, Crazy Creek campground, 22 Aug 1953, *Lawton 2019* (WTU), det. R. Pursell. Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft. 42°57'30"N, 109°36'W, mineralized seeps at S end of lake *Fissidens osmundoides,* 14 May 1989, *Andrus 7795b* (BING).

The *Lawton 2019* specimen had a costae ending short of the apex, vaginant laminae long and broad, cells of vaginant laminae epapillose, and rhizoids papillose (noted by R. Pursell).

Fissidens sublimbatus Grout, Moss Fl. N. Amer. 1: 13, plate 13, fig. A. 1936.
Fissidens obtusifolius var. *apiculatus* Grout

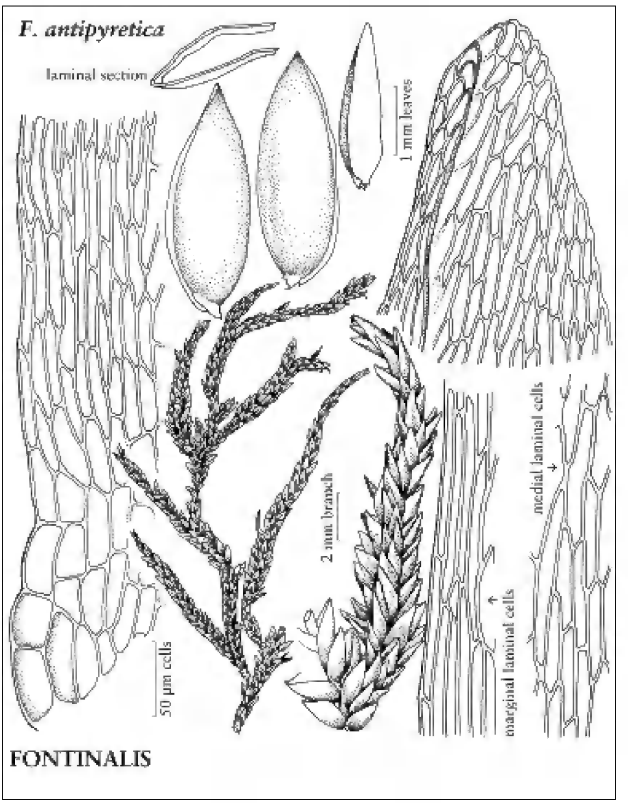
Wyoming (FNA Vol. 27, 2007). A species of soil in the arid lowlands in Wyoming, "...often partially buried, often under overhanging rocks and boulders, and in the shade of trees and shrubs" (Ireland, FNA Vol. 27, 2007). It is found in the arid states, south of Wyoming, such as New Mexico and Arizona and "Indeed, it appears to be the only species of the genus found in Death Valley" (Ireland FNA).

FONTINALIS Hedw., Sp. Musc. Frond., 298. 1801. (Fontinalaceae)

Fontinalis antipyretica Hedw., Sp. Musc. Frond., 298. 1801. (*Fontinalis* s.l.)
Fontinalis allenii Card.
Fontinalis antipyretica var. *gigantea* (Sull. ex Sull. & Lesq.) Sull.
Fontinalis antipyretica var. *mollis* (Müll. Hal.) Welch

Fontinalis antipyretica var. *oreganensis* Ren. & Card.
Fontinalis antipyretica var. *patula* (Card.) Welch in Grout
Fontinalis antipyretica var. *robusta* Card.
Fontinalis californica Sull.
Fontinalis gigantea Sull.
Fontinalis mollis Müll. Hal.
Fontinalis patula Card.
Fontinalis utahensis Card. & Thériot
Pilotrichum antipyretica (Hedw.) Müll. Hal.

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1529*) (Roell 1893). Medicine Bow Mts., Albany County (Nelson 9670), Porter (1935). *Fontinalis gigantea* Sulliv. Albany County, Carbon County, and Sheridan County, Porter (1935). (As *Fontinalis antipyretica* var. *gigantea* Sulliv.) Albany, Carbon, Sheridan cos., Porter (1937). (As *F. antipyretica* var. *mollis* (Müll. Hal.) Welch) Albany, Carbon cos., Porter (l937), and Lawton 1971). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010). (As *Fontinalis antipyretica* var. *oregonensis* Ren. & Card.): Lincoln Gulch, Albany Co. (*Nelson 2619*), Porter (1935).



Courtesy FNA Association, FNA 28, 2014

Albany Co.: Lincoln Gulch, 12 Aug 1896, *Nelson 2619* (RM); W of Bear Tooth Butte along the Clark Fork of the Yellowstone River, 6940 ft, *Lawton 2004* (WTU), small pond of cold water in spruce-fir forest at University of Wyoming Science Camp, Centennial, *Dennings 1091* (WTU); swift streams, Medicine Bow Mts., *Nelson 9670,* exsiccat Plants of Wyoming (RM). Carbon Co.: submerged & partly floating in pool in marsh near North French Creek at logging road crossing, 8600 ft, Medicine Bow Mts., 6 mi E of Ryan Park, *Hermann 26719* (WTU); cold, shallow pool in meadow along North French Creek, Medicine Bow Mts., ca. 8500 ft, 6 mi E of Ryan Park, 19 Aug 1961, *Hermann 17186* (RM). Park Co.: Bear Tooth Mts., Crane Lake, in water, attached to rocks, *Welch 15079* (WTU). Sublette Co.; 10,324 ft, *Rolston 85127* (CSU); also 10,595 ft, *Rolston 85099* (CSU).

(As *Fontinalis antipyretica* var. *gigantea* (Sull.) Sull.): Albany Co.: in the swift water of the stream, Centennial, 7 Aug 1900, *Nelson 8001*, exsiccat, det. Holz. (RM). Fremont Co.: in the Popo Agie River S of Lander, 5200 ft, 30 Jul 1966, *Scott 883* (RM). Sheridan Co.: in spring bog, 29 Jul 1901, *Nelson 8521* (RM).

Fontinalis antipyretica var. duriaei (Schimp.) Husn. = Fontinalis hypnoides Hartman

Fontinalis antipyretica var. hypnoides = Fontinalis hypnoides Hartman

Fontinalis hypnoides Hartman, Handb. Skand. Fl. ed. 4, 434. 1843.
Fontinalis dalecarlica var. *macounii* Card.
Fontinalis duriaei Schimp.
Fontinalis Holzingeri Card.
Fontinalis macmillanii Card.
Fontinalis nitida Lindb. & Arnell
Fontinalis nitida var. *angustiretis* Card. ex W.H. Welch
Fontinalis obscura Card.
Fontinalis subcarinata Card.
Fontinalis tenella (Card.) Card.
Fontinalis umbachii Card.

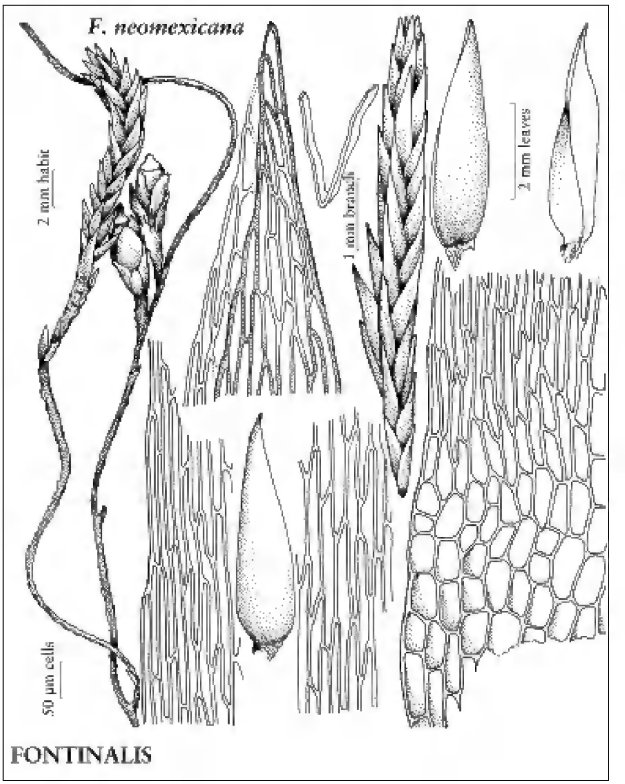
Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1554, 1582* and *1583*) (Roell 1893). (As *Fontinalis antipyretica* var. *duriaei* (Schimp.) Husn. or as *Fontinalis duriaei* Schimp.) N. Vermillion Creek, Sweetwater County (*Nelson 3577*). "No specimens of this plant could be found although it is recorded by Dr. Nelson (1900)," Porter (1935). (As var. *duriaei*) North Vermillion Creek, *Nelson 3577* (RM). (As *Fontinalis antipyretica* var. *duriaei* (Schimp.) Husn.) Specimens that are "larger, laxer, and softer, with relatively broad leaves being the var. duriaei...smaller ones with relatively narrow leaves the var. hypnoides." (*Fontinalis hypnoides* C.J. Hartm. var. *hypnoides* Albany Co., Yellowstone Natl Park, Porter (1937). (As *Fontinalis hypnoides*) Albany County and Yellowstone Natl Park, Porter (1935). (As *Fontinalis nitida* Lindb. & Arn.) Moorcroft, Crook County (*Nelson 2248*), Porter (1935). (As *Fontinalis duriaei* Schimp.) Sweetwater Co., Porter (1937). (As *Fontinalis nitida* Lindb. & Arn.) Crook Co., Porter (1937). Teton Co., Spence (1985).

Albany Co.; Hermann, 17781 (RM). (As var. *hypnoides* but sub *duriaei*) Little Laramie River, *Nelson 3328* (RM). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Fontinalis antipyretica* var. *duriaei* (Schimp.) Husn.) Albany Co.: Yuncker 12370 (RM); 10,000 ft, *Hermann 17221* (RM). Yellowstone Natl Park: 2 mi E of Fishing Bridge, Indian Pond, layered in the stack of diatom deposits about 20 ft in height, between Indian Pond and Yellowstone Lake, 12 Jun 1989, *Shero s.n.* (BUF).

(As *Fontinalis hypnoides*) Fremont Co.; 10,055 ft, *Rolston 86029* (CSU). Sublette Co.: Bridger Wilderness, Wind River Range ca. 1/4 mile SW of Barnes Lake, 9780 ft, 42°59'N, 109°36'W, floating in small lake with fen margin (leaves not keeled), 15 May 1989, *Andrus 7814* (BING).

"Plants of *F. antipyretica* found in swiftly moving streams often have leaves completely split along the keel and can be mistaken for *F. hypnoides*" (Allen in FNA Vol. 28, 2014)



Courtesy FNA Association, FNA 28, 2014

Fontinalis neomexicana Sull. & Lesq. in W.S. Sullivant, Musc. Hepat. U.S., 224b. 1856 (as neomexicana).
Fontinalis columbica Card.
Fontinalis maritima Müll. Hal.
Fontinalis mercediana Lesq.

Wyoming (FNA Vol. 28, 2014). Albany County, Johnson County, Sheridan County, and Yellowstone Natl Park, Porter (1935). Albany, Johnson, Sheridan cos., Yellowstone Natl Park, Porter (1937). (As *Fontinalis neomexicana* var. *columbica* (Card.) Card.) Spring Creek, Yellowstone Natl Park (Nelson 6293), Porter (1935).

Albany Co.; 7800 ft., *Hermann 25931* (RM); *Nelson 7540 (*RM); *Nelson 7540,* c.fr. (RM). Carbon Co.; 9200 ft, *Porter 9694* (RM). Johnson Co.; *Nelson 2506* (RM); Big Horn Mts., Sep 1892, *Hapemann s.n.* (RM). Yellowstone Natl Park: *Nelson &Nelson 6320* (RM); *Nelson & Nelson 6293* (RM).

FUNARIA Hedw., Sp. Musc. Frond., 172. 1801. (Funariaceae)

[*Funaria flavicans* Michaux, Fl. Bor.-Amer. 2: 303. 1803, probably excluded]

Not reported for Wyoming by FNA (FNA Vol. 27, 2007).

Centennial, Albany County (*Nelson 8699*); Dale Creek, Albany County (*Porter 712*), Porter (1935). Crum and Anderson (1981) and FNA (2007) report this species to not occur west of Missouri, Kansas and Nebraska.

Funaria hygrometrica Hedw., Sp. Musc. Frond.,172. 1801.

Var. **hygrometrica**
Funaria convoluta Hampe
Funaria flaviseta Warnst.
Funaria hygrometrica var. *β* B.S.G.
Funaria hygrometrica var. *patula* Aust.
Funaria hygrometrica var. *utahensis* Grout)

Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park c.fr., (*1493*) (Roell 1893). In all states and provinces of the Pacific Northwest; throughout the USA and Canada, cosmopolitan. (As *Funaria convoluta*) French Creek, Carbon County (*Goodding 2029*); (as *F. hygrometrica*) Albany, Sheridan, Sublette cos., Yellowstone Natl Park, Porter (1935). (As var. *utahensis*) Albany, Carbon cos., Porter (1937). (As var. *utahensis*) Wyoming, Flowers (1973).

Albany Co.: (as var. *utahensis*) Laramie, 29 Jul 1897, *E. Nelson 3453*; *Nelson 3461,* c.fr. (RM). Big Horn Co.: Big Horn Mtns., North Nork Crazy Woman Creek, 13 air mi SW of Buffalo, limestone outcrops and rocky slopes, shaded streamside, aspen woodlands and meadows, 6800 ft, c.fr., 28 Jun 1979, *Hartman 9708,* operculate (BUF, RM). Carbon Co.: (as var. *utahensis*) French Creek, wet ground in burnt alder patch, 28 Aug 1903, *Goodding 2029* (RM), (as var. *utahensis*). Johnson Co.: T49N R 83W S22, Big Horn Mts., North Fork Crazy Woman Creek, ca. 13 air mi SW of Buffalo; Sect. 22 & 27, limestone outcrops and rocky slopes, shaded streamside, and aspen woodlands with adjacent meadows; 6800 ft, 28 Jun 1979, *Hartman 9708* (RM). Park Co.: 6100 ft, 1 Apr 1988, *Vukelich s.n.* (BUF). Natrona Co.: Big Horn Mts., First Water Creek, dry creek bed and road crossing, 7700 ft, 1 Aug 1979, *Hartman 10452*, c.fr., operculate (RM).

The capsules in *Nelson 3453* are short pyriform and uniformly smaller than the typical variety, as detailed by Flowers (1973). A collection at RM in a packet of *Bryum lisae* var. *cuspidatum* approached the variety in the smallness of the capsules, except no spores were larger than 17 to 18 µm. The capsules were green and not furrowed. Since the operculum had dehisced and the spores appeared normal, one might assume the capsules were mature: *Nelson 1538* (RM), Albany Co. Cummins, Jul 30 1895, with *Hennediella heimii* and *Bryum lisae* var. *cuspidatum*.

Funaria hygrometrica var. *calvescens* (Schwaegr.) Mont. "seems to be a tropical expression of the species although it is known from a few southern states in the United States" (Miller & Miller, FNA Vol. 27, 2007).

GEMMABRYUM J.R. Spence & H.P. Ramsay, Phytologia 87: 63. 2005. (Bryaceae)

Gemmabryum caespiticium (Hedw.) J.R. Spence, Phytologia 91: 497. 2009.
Bryum caespiticium Hedw., Sp. Musc. Frond. 180. 1801.
Bryum julaceum Kindb.
Bryum microcephalum Müll. Hal. & Kindb. in Macoun
Bryum oligochloron Müll. Hal. & Kindb. in Macoun
Bryum synoicocaespiticium Müll. Hal. & Kindb. in Macoun
Bryum vancouveriense Kindb. in Macoun
Ptychostomum imbricatulum (Müll. Hal.) D.T. Holyoak & N. Pederson

Wyoming (FNA Vol. 28, 2014). (As Bryum caespiticium): Wyoming: Yellowstone Natl Park, c.fr., (*1516, 1519*) (Roell 1893). (All as *Bryum caespiticium*) Widespread, almost cosmopolitan. Albany, Carbon Co., Uinta, Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Campbell Co., Medina (1994).

Albany Co.: S bank of Little Brooklyn Lake, Medicine Bow Mtns., 10,300 ft, *Schriever 17* (RM); (as *Bryum provinciale* Philib.) Medicine Bow Mts., *Nelson 7814,* (RM, US); Cummins, with *Hennediella heimii* and *Funaria hygrometrica,* 30 Jul 1895, *Nelson 1538,* see Porter citation of this specimen below, c.fr. (RM). BIG HORN CO.: Big Horn Mtns., large rock outcrop, 9200 ft, c.fr., indehisced operculate, 9 Jul 1979, *Nelson 3332* (BUF, RM), with *Bryoerythrophyllum recurvirostrum*. Carbon Co.: Pedro Mts., *Goodding 115* (RM, US); Plants of Wyoming, Bridger Peak, *Goodding 1966* of the exsiccat, det. by Holz. (as *B. occidentale* Sull.) (RM, US). Fremont Co.: Bridger-Teton Natl Forest on US 26 & US 287, between Moran & Dubois, ca. 9000 ft, wet with flowing streams, granite outcrops, N slopes of knoll, with *Tortula ruralis, Encalypta vulgaris* var. *rhabdocarpa*, *Eckel 93081102,* c.fr. (BUF). Sublette Co.: 7950 ft, *Hermann 25344* (RM). Uinta Co.: Fort Bridger, 8 Jun 1898 (young), *Nelson 4595* (RM); Evanston, on dry ground, 8 Jul 1942, *Degener 17074,* c.fr. (US). Yellowstone Natl Park: Yellowstone Lake, in a wet draw, 23 Aug 1899, *Nelson 6640* (RM, US); Blacktail Deer Creek, on ground, 1 Aug 1888, *Knowlton, s.n.* (US).

Smith (1978) gives a good illustration of the abruptly acuminate apex. Note that this character is evident at least on some of the leaves (otherwise this is not definitely demonstrable). In the Big Horn Co. specimen, this species was growing with *Bryoerythrophyllum recurvirostrum* in a harsh habitat. Both taxa were capable of growing from robust in size down to tiny buttons in the sand—I have not found *Bryum lisae* var. *cuspidatum*, the other weedy taxon so like *B. caespiticium*, to be capable of this diminution of size. The *Bryoerythrophyllum* can also become ver small. Another specimen from Big Horn Co. shows that this taxon, when depauperate, has a short, ropy habit with a gristled appearance, like the stem tips are little curling steel wires. In fruit, the fertile stem is a bulb in the sand, the innovations on red stalks with bulblike leaf-wrap. The colors are a Christmas red and green. It seems most of the weedy things I've been looking at are synoicous—this one is refreshingly dioicous. Its costa is significantly longer than the other weedy things. It has a weak border.

More robust specimens are different, unfortunately, but the stem is usually shorter (under 1 cm) than the run of common Bryums. I find the leaf cells can be quite thick. Crum gives an excellent description of this plant—the operculum can be quite apiculate with a prominent nipple at the tip. Note that the description of *B. caespitosum* with linear cells in the apex is a characteristic of the

sterile stems: the fertile ones have shorter cells and shorter awns (is this also true in *Rosulabryum capillare*). (Both *B. caespitosum* and *B. lisae* may have bright orange setae.) The specimen of Goodding 1966 seen from both RM and US had numerous small innovations that might be taken as bulbils. One might usually expect innovations as branchings but in Goodding's specimens they appeared to be free and developing from rhizoids or generally unattached or readily deciduous from any main stem (cf. *B. canariense*: "with short axillary branches becoming detached and acting as asexual reproductive structures). These apparent branchlets are in fact stems and may carry the male organs: in *B. pallescens*, the side axes are actually branches, without rhizoids, and so the plant is autoicous (*B. caespitosa* is dioicous). The leaves of sterile stems all had regularly excurrent costae, just as those of the fertile stems. The capsules were variable from under 2 mm to nearly three mm, none of them red—characters not associated with *Gemmabryum dichotomum* (see below). Note the variability of the capsule sizes, as recognized in Flower's description of the species, from below 1 to 3 mm.

Gemmabryum dichotomum (Hedw.) J.R. Spence & H.P. Ramsay, Phytologia 87: 66. 2005.
Bryum dichotomum Hedw., Sp. Musc. Frond. 183, plate 42, figs. 8–12. 1801.
Bryum bicolor Dickson
Gemmabryum bicolor (Dickson) J.R. Spence

Not reported for Wyoming in FNA (FNA Vol. 28, 2014), but widespread, occurring in the western states. (As *Bryum dichotomum*) Teton Co., Spence (1985).

GRIMMIA Hedw., Sp. Musc. Frond., 75. 1801. (Grimmiaceae)
Dryptodon Brid.; *Hydrogrimmia* (I. Hagen) Loeske

Grimmia affinis Hornsch. = Grimmia longirostris Hook.

Grimmia agassizii (Sull. & Lesq. in Sull.) A. Jaeg. = *Schistidium agassizii* Sull. & Lesq.

Grimmia alpestris (Weber & Mohr) Schleicher, Cat. Pl. Helv. ed. 2, 29. 1808.
Trichostomum pulvinatum var. *alpestre* Weber & Mohr, Bot. Taschenbuch, 110. 1807.
Grimmia donniana var. *alpestris* (Weber & Mohr) Hampe

Wyoming (FNA Vol. 27, Vol. 27).

Grimmia alpicola Hedw. = Schistidium agassizii Sull. & Lesq.

Grimmia alpicola auct. Amer. = Schistidium rivulare (Brid.) Podp.

Grimmia alpicola var. latifolia (Zett.) Mill. = Schistidium rivulare (Brid.) Podp.

Grimmia anodon P. Bruch & Schimp., Bryol. Europ. 3: 110. 1845.
Grimmia anodon var. *anomala* Bartr.
Grimmia subanodon Ochyra
Schistidium anodon (B.S.G.) Loeske
Schistidium obtusifolium Ireland & H.A. Crum

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the P. Nw.; Yukon, Cal., Ariz. N.M, Nev., Utah, Colo., N. Dakota. Telephone Canyon, Albany Co. (*Porter 1014*); Long Canyon, Albany Co (*Rollins 61*), Porter (1935). Yellowstone/Teton localities are given in a map by Ireland & Miller (1982). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Laramie Mtns, Roger Canyon, ca. 8 air mi NE of Laramie, Co. Rd. 17, limestone outcrops with *Cercocarpus montanus*, 7 Jun 1993, *Buck 23169* (NY); along Roger Canyon in the Laramie Mtns, 7 mi due NE of Laramie city center, *Artemisia* scrub vegetation, limestone cliffs and outcrops, 7600 ft, vertical seeping crack in limestone cliff, 7 Jun 1993, *Reese 18158* (LAF) with *Orthotrichum hallii*; Laramie Mountains, Roger Canyon, 7 air mi NE of Laramie city center, limestone outcrops with *Cerocarpus montanus*, *Artemisia cava*, *A. tripartita*, *A. nova*, *A. tridentata,* on thin soil over bedrock, 7 Jun 1993, *Miller 10,234* (NYS); crevices in quartz boulder on open slope above University of Wyoming Science Camp, 9800 ft, Medicine Bow Mtns., 7.8 mi NW of Centennial, 1 Sep 1970, *Hermann 23426* (RM). Fremont Co.: on limestone outcrop, Douglas fir slope, 1/2 mi E of Horse Creek Campground, 7800 ft, Absaroka Range, 11 mi N of Dubois, 28 Aug 1973, *Hermann 25531 (*RM). Platte Co.: *Eckel 1020386* (RM).

Grimmia anomala Hampe in W.P. Schimper, Syn. Musc. Eur. ed. 2, 270. 1876.
Dryptodon anomalus (Hampe) Loeske
Grimmia anomala Hampe in Schimp.
Grimmia elatior subsp. *anomala* (Hampe) Kindb.
Grimmia hartmanii var. *anomala* (Hampe) Mönk.
Grimmia pachyneurula Müller Hal & Kindb.
Grimmia philibertiana Britt.
Grimmia phyllantha Lindb. in Broth.

Wyoming (FNA Vol. 27, 2007). British Co., Wash., Alberta, Idaho, Mont., Wyoming; Michigan. Teton Co., Spence (1985).

Grimmia apocarpa Hedw.= Schistidium apocarpum (Hedw.) P. Bruch & Schimp. in B.S.G.

Grimmia apocarpa var. conferta (Funck) Spreng. = Schistidium apocarpum (Hedw.) P. Bruch & Schimp. in B.S.G.

Grimmia apocarpa var. stricta (Turn.) Hook. & Tayl. = Schistidium apocarpum (Hedw.) P. Bruch & Schimp. in B.S.G.

Grimmia atricha Müll. Hal. & Kindb. in Macoun & Kindb. = Schistidium apocarpum (Hedw.) P. Bruch & Schimp. in B.S.G.

Grimmia calyptrata Hook. in Drumm. = Coscinodon calyptratus (Hook. in Drumm.) C.E.O. Jens. ex Kindb.

Grimmia donniana Smith in J. E. Smith et al., Engl. Bot. 18: plate 1259. 1804.

Wyoming (FNA Vol. 27, 2007). "*Grimmia donniana* is widespread but relatively uncommon and sporadic along the front ranges of the Rocky Mountains from Alberta south to southern Utah and Colorado" (Hastings & Greven in FNA Vol. 27, 2007). Johnson Co., Porter (1937). Uinta Co., Wynne (1943).

Grimmia dupretii Thér. = Schistidium dupretii (Thér.) Weber

Grimmia elatior Bruch ex Balsamo-Crivelli & De Not., Mem. Reale Accad. Sci. Torino 40: 340. 1838.
Dryptodon incurvus (Hornsch.) Brid.
Grimmia cognata Card. & Thér.

Grimmia elatior subsp. *rufescens* Kindb.
Grimmia funalis var. *robusta* De. Not.
Grimmia grandis Kindb.
Grimmia papillosa (Warnst.) Kindb.
Rhacomitrium incurvum (Hornsch.) Hüb.
Trichostomum incurvum Hornsch.

Wyoming (FNA Vol. 27, 2007). British Columbia, Mont., Wyoming; Colo. Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 7800 ft, *Hermann 25924* (RM). Park Co.: 3250 m, 21 Aug 1973, *Weber s.n.*. (COLO). Teton Co.: 7000 ft, *Hermann 25553* (RM).

[*Grimmia funalis* (Schwägr.) P. Bruch & Schimp., Bryol. Europ. 3: 119, fig. 247. 1845, excluded]

Not reported for Wyoming by FNA (FNA Vol. 27, 2007) where the distribution is north-south from above the Arctic Circle south to Louisiana in a line of less than 10 sites. Wyoming: Yellowstone Natl Park, Upper Falls (1478) (Roell 1893).

Grimmia hartmanii var. anomala (Hampe ex Schimp.) Mönk. = Grimmia anomala Hampe ex Schimp.

Grimmia laevigata (Brid.) Brid., Bryol. Univ. 1: 183. 1826.
Campylopus laevigatus Brid., Muscol. Recent., suppl. 4: 76. 1818.
Grimmia campestris Burchell ex Hook.
Grimmia glauca Card.
Grimmia leucophaea Grev.
Grimmia sarcocalyx Kindb. in Macoun

Wyoming (FNA Vol. 27, 2007). Wash., Oregon, Idaho, Wyoming; Cal. Nev., Utah, Ariz, N. Mexico; widespread in the midwest and in the eastern states from NY to New Jersey to Fla.

Grimmia glauca Card. from Albany Co., Porter (1937) may be a citation of *G. laevigata* following Crum and Anderson's (1981: 424) synonymy: *G. glauca* sensu Jones in Grout, Moss Fl. Amer., Vol. 2(1), p. 24 1940, non Card. 1905. (As *Grimmia glauca* Card.) "A rare plant, this being one of the four known collections in the United States. On metamorphosed limestone rocks, Long Canyon, Albany County (Rollins, 60)," Porter (1935).

Grimmia longirostris Hook., Musci Exot. 1: plate 62. 1818.
Grimmia affinis Hornsch.
Grimmia arctophila subsp. *labradorica* Kindb.
Grimmia catalinensis Bartr.
Grimmia catalinensis var. *mutica* Bartr.
Grimmia elata Kindb.
Grimmia ortholoma Kindb.
Grimmia ovalis var. *affinis* (Hornsch.) Broth.
Grimmia ovata var. *affinis* (Hornsch.) P. Bruch & Schimp.
Grimmia ovateoformis (sic) Kindb.

(As *Grimmia affinis*) British Columbia, Washington, Alberta, Idaho, Montana, Wyoming; Alaska, Colorado, Arizona, New Mexico; South Dakota, Minnesota. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Grimmia affinis*) Albany Co.: *Nelson 5243* (RM). Sublette Co.: on shaded boulder under spruce on W shore of Lower Green River Lake, 7950 ft, Wind River Range, 50 mi N of Pinedale, 19 Jun 1973, *Hermann 25323* (RM). Yellowstone Natl Park: *Bartley & Pontious 13* (RM).

The specimen *Hermann 25323* looked like *G. ovalis* (long basal cells, sinuose median cells, moderately toothed hairpoint) but it keyed to *G. affinis* (second reference in Lawton's1971 key) through the keeled leaves recurved on one side. This species is difficult to distinguish from *Grimmia pulvinata* except it has a straight seta and that of the latter is arcuate (at least when moist, as they say). *Grimmia affinis* has basal cells that are not "subquadrate to short rectangular" but longer, getting shorter toward the margins and thinner-walled. Both are variably thick-sinuose—these characters are best seen in older leaves. *Grimmia affinis* has occasional "subcuculate" calyptrae, otherwise both are mitrate. The basal cells of *Grimmia pulvinata* are rather homogeneously thin-walled, that of *G. affinis* variable: longer and thicker toward the costa becoming shorter and thinner on the margins. Both with thickened cross-walls on the marginal two or three lengths of cells. Bistratose patches occur on the lamina, in addition to bistratose margins.

Grimmia montana P. Bruch & Schimp., Bryol. Europ. 3. 128. 1845.
Grimmia arctophila Kindb.
Grimmia brachydon Aust.
Grimmia jamesii Aust.
Grimmia montana var. *brachydon* (Austin) Lesq. & James
Grimmia montana var. *idahensis* Ren. & Card. in Card. & Thér.
Grimmia pseudomontana Card. & Thér.
Grimmia tenella Müll. Hal.
Guembelia montana (B.S.G) Hampe in Müll. Hal.

Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park 7000 ft, (*1467*), Lower Geyser (*1462, 1465*) Upper Falls (*1464, 1471*) (Roell 1893). Albany County (Porter 1011); Sublette County (*Porter 1125 & 1127);* Teton County (Porter 1171); and Tower Falls, Yellowstone Natl Park (collector unknown), Porter 1935. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 8000 ft, *Hermann 17721* (RM). Park Co.: 7500 ft, *Hermann s.n.* (RM).

Grimmia occidentalis Lawton = Schistidium occidentale (Lawton) Churchill

Grimmia ovalis (Hedw.) Lindb., Acta Soc. Sci. Fenn. 10: 75. 1871.
Dicranum ovale Hedw., Sp. Musc. Frond., 140. 1801.
Grimmia commutata Hüb.
Grimmia ovata Web. & Mohr
Grimmia ovata var. *gracilis* Röll

Wyoming (FNA Vol. 27, 2007).

(As *Grimmia ovata*) Wyoming: Yellowstone Natl Park, Upper Falls (*1459*) (Roell 1893). B.C., Wash., Idaho, Mont., Wyoming; Nev. Ariz. (As *Grimmia commutata*) Brooklyn Lake, Albany County (*Nelson 5243);* near Pinedale, Sublette Co. (*Porter 1126*), (as Grimmia ovalis: Teton cos., Yellowstone Natl Park), Porter (1935). Teton Co., Spence (1985).

Albany Co.: Sheep Mt., on dry cliffs, *Goodding 2101* (RM), exsiccat Plants of Wyoming. Platte Co.: *Eckel 1420386* (RH, BUF).

Grimmia plagiopodia Hedw., Sp. Musc. Frond., 78, plate 15, figs. 6–13. 1801.
Grimmia brandegeei Aust.
Grimmia obtusa Brid.
Schistidium plagiopodium (Hedw.) Loeske

Wyoming (FNA Vol. 27, 2007). B.C., Oregon, Alberta, Mont., Wyoming; Ariz., New Mex., Colo.; S. Dakota, Iowa, Ohio, Maryland. Sweetwater Co., Weston Co., Wynne (1943).

Niobrara Co.: 4000 ft, *Hermann 25355* (RM). Weston Co.: *Eckel 823686* (RM, BUF).

Grimmia pulvinata (Hedw.) Smith in J. E. Smith et al., Engl. Bot. 24: plate 1728. 1807.
Fissidens pulvinatus Hedw., Sp. Musc. Frond., 158, plate 40, figs. 1–3. 1801
Campylopus pulvinatus (Hedw.) Brid.
Dryptodon pulvinatus (Hedw.) Brid.
Fissidens pulvinatus Hedw.
Grimmia decipiens var. *hendersoni*i (Ren. & Card.) Sayre
Grimmia hendersoni Ren. & Card.
Grimmia indianensis (Sayre) Crum
Grimmia subcurvula Kindb.
Grimmia trichophylla var. *indianensis* Sayre

Wyoming (FNA Vol. 27, 2007). In all states and prov. of the Pacific Northwest; Cal., Nev., Utah, Ariz.; TX, Iowa, Missouri, Maryland. Carbon Co., Wynne (1943). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 8700, *Hermann 24863* (RM). Park Co.: granite outcrop along road ca. 11 mi SE of Rte. 212, Shoshone Natl. Forest, 33 mi NW of Cody, 19 Jul 1965, *Hermann 20025* (RM). Johnson Co.: on the rocks in the shade of pines, Middle Fork of Powder River, 16 Jul 1901, *Goodding 263* (RM).

The setae are arcuate when dry—a plant of specimen Hermann 20025 developed a straight seta on drying. The awns are conspicuously long, as long as the leaves, and the basal cells rather thin to hyaline and not at all or somewhat sinuose. There is a var. *africana* (Hedw.) Hook.f. in the 1990 checklist. See *Grimmia affinis* for discussion with regard to its distinction from this species.

Grimmia tenera Zett. = Schistidium tenerum (Zett.) Nyh.

Grimmia sessitana De Not., Atti Reale Univ. Genova 1: 704. 1869.
Grimmia alpestris (Web. & Mohr) Schleich. ex Hornsch. var. *alpestris*
Grimmia subpapillinervis Kindb.
Grimmia tenerrima Ren. & Card.
Guembelia alpestris (Web. & Mohr) Hampe in Müll. Hal.
Trichostomum pulvinatum var. *alpestris* Web. & Mohr

(As *Grimmia tenerrima*) In all states and provinces of the Pacific Northwest; California, Arizona, Nevada, Utah, Colorado; Labrador, Quebec. (As *Grimmia alpestris* Schleich.) Fairly common. Albany, Big Horn, Sublette, Sweetwater, Teton (& Washakie) cos., Porter (1935). (As *Grimmia alpestris*) "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, (Spence 1981).

(All as *Grimmia tenerrima*) Albany Co.: Medicine Bow Mts., Silver Lake, growing on granitic boulder in open area, infrequent, 9000 ft, 24 Sep 1977, *Lichvar 1338* (RM). Fremont Co.: soil pocket on boulder in open woods on slope, W shore of Fiddler's Lake (Wyo. Rte 131), 9300 ft, 22 mi SSW of Lander, 18 Jun 1973, *Hermann 25296* (RM). Lincoln Co.: on granite boulder on slope above Salt River, Silver Stream Motel, 6000 ft, 11 mi N of Ashton, 11 Aug 1962, *Hermann 17842* (RM). Platte Co.: *Eckel 920386* (RH), according to a det. by McIntosh. Sublette Co.: on boulder in open spruce-pine woods, W shore of Lower Green River Lake, Wind River Range, 7850 ft., 50 mi N of Pinedale, 19 Jun 1973, *Hermann 25315* (RM); South Fork of Baldy Creek headwaters, 10,290 ft, on damp rock at edge of fen, 42°59'N, 109°34'W, with *Didymodon umbrosus,* 16 Aug 1989, *Andrus 7833a* (BING, BUF)

(As *Grimmia tenerrima*) *Grimmia sessitana* is of the smaller group of Grimmias, dark with awns that are frequently decurrent along the lamina at the apex of the leaf. What is very striking are the basal margin cells, quadrate with thicker crosswalls than the longitudinal walls. They have two layers of cells at the apex, double layers at the margins medially with patches of bistratose lamina. It is useful to make cross Sect.s of these leaves to verify they are not recurved, but only have thickened marginal cells due to several layers of cells. The leaves are keeled toward the leaf tips in many leaves—other leaves lie flat. *Grimmia sessitana* is "our most common species of *Grimmia* in the higher mountains of Utah" according to Flowers (1973), and it is usually sterile, which is somewhat unusual in a *Grimmia*, so if you have extensive material in your specimen and it is sterile, check to see if it is glaucous, that is, if it has a bluish cast. It has hairpoints and is dioicous. The costa is terete in the sense that it is well set off from (not confluent with) the lamina), but is somewhat flattened in longitudinal axis. There is a sharp little groove on the topside of the costa, and this can be seen on the leaves lying flat up at you: the costa is nested in a channel. The leaves are keeled.

Grimmia tenerrima Ren. & Card. = Grimmia sessitana DeNotaris

Grimmia torquata Drumm., Musc. Scot. 2: no. 28. 1825.
Dryptodon torquatus (Hornsch.) Brid.
Grimmia pellucida Kindb.
Grimmia prolifera Müll. Hal. & Kindb. in Macoun
Grimmia pseudotorquata Kindb.
Grimmia tortifolia Kindb.

Wyoming (FNA Vol. 27, 2007). In all states and prov. of the Pacific Northwest; Alaska, Cal., Nev., Colo., Ontario, Greenland. (As *Grimmia torquata* Hornsch. Fruiting plants were collected in Wyoming by Roell in 1893, Yellowstone Natl Park, 7000 ft (*Roell 1439* p.p., 1440 p.p.) "the specimen from Yellowstone has only a single tall capsule" (Roell 1893), Porter (1937.)

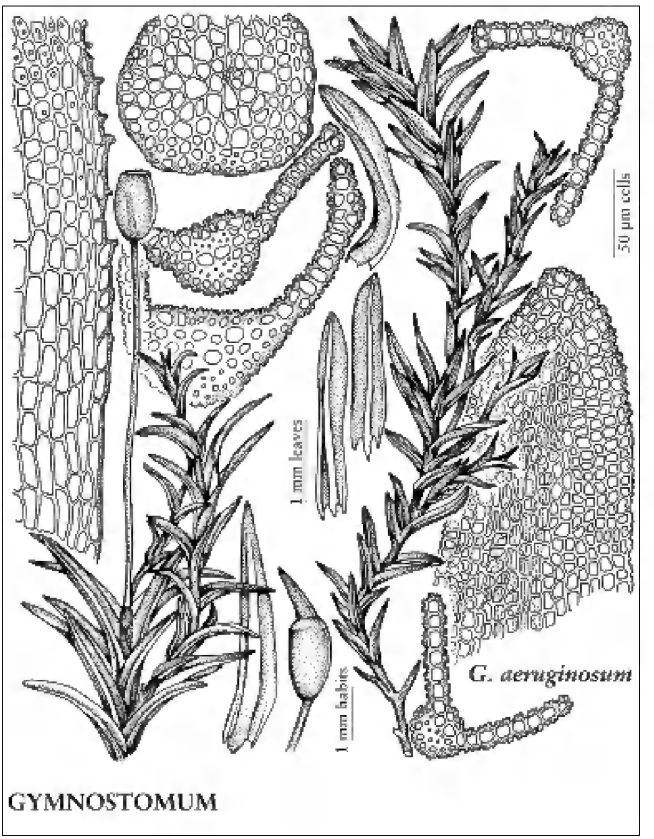
Sublette Co.: 10,348 ft, *Rolston 85133* (CSU).

There is a var. *flettii* (Holz.) Vaar. in Anderson et al. (1990) checklist.

Grimmia trichophylla Grev., Fl. Edin., 235. 1824.
Dryptodon trichophyllus (Grev.) Brid.
Grimmia californica Sull. in Whipple
Grimmia canadensis Kindb.
Grimmia cognata Card. & Thér.
Grimmia densa Kindb. in Macoun
Grimmia depilata Kindb. in Macoun
Grimmia leibergii Paris
Grimmia pachyphylla Leib.

Wyoming (FNA Vol. 27, 2007). B.C., Wash., Oregon, Idaho, Mont., Wyoming; Cal. Nev. Hawk's Ranch, Albany County (Nelson in 1930), (Johnson Co.); Jenny Lake, Teton County (*Porter 1206*), Porter (1937). Teton Co., Spence (1985).

Grimmia wrightii (Sull.) Aust. = Jaffueliobryum wrightii (Sull. in Gray) Thér.



Courtesy FNA Association, FNA 27, 2007

GYMNOSTOMUM Nees & Hornschuch in C. G. D. Nees et al., Bryol. Germ. 1: 112. 1823, name conserved. (Pottiaceae)

Gymnostomum aeruginosum Smith, Fl. Brit. 3: 1163. 1804.
Anoectangium arizonicum Bartram
Gymnostomum clintonii Aust.
Gymnostomum rupestre Schleich. ex Schwaegr.
Gymnostomum tophaceum Aust.
Weisia rupestris (Schwaegr.) Müll. Hal.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest but not common; Alaska, California, Nevada, Arizona; Minnesota, Iowa, Wisconsin, Michigan, Ontario; Quebec, New York, Ohio, Pennsylvania, Tennessee.

Big Horn Co.: 8800 ft, *Hartman & Odasz 9146* (RM). Park Co.: 2324–2350 m, *Duell 2269.4* (BUF). Washakie Co.: on limestone boulders in a shady canyon, Ten Sleep Canyon, Big Horn Mts. 8000 ft, 9 Sep 1935, *Porter 2094*. Yellowstone Natl Park: near Gardner River, 16 Aug 1953, *Lawton 1819* (WTU).

[*Gymnostomum calcareum* Nees & Hornsch. in Nees et al., excluded]

Not reported for Wyoming by FNA (FNA Vol. 27, 2007) and probably not found there.

Washakie Co., Porter (1937). Probably *Gymnostomum aeruginosum*, v. discussion in Crum & Anderson (1981: 285). North American citations are perhaps juvenile forms of *G. aeruginosum*. This species occurs, however, in southern California. The specimen from WTU of *Porter 2094*, "On limestone boulders in a shady canyon" from the Ten Sleep Canyon in the Big Horn Mts, Washakie Co.: has been determined to be *Gymnostomum aeruginosum* by R. Zander. The specimen in Sect. shows a ventral costal epidermis, two stereid bands, and a central strand in the stem. The capsules were young and so rather ovoid.

Gymnostomum curvirostre Hedw. ex Brid. = Hymenostylium recurvirostre (Hedw.) Dix.

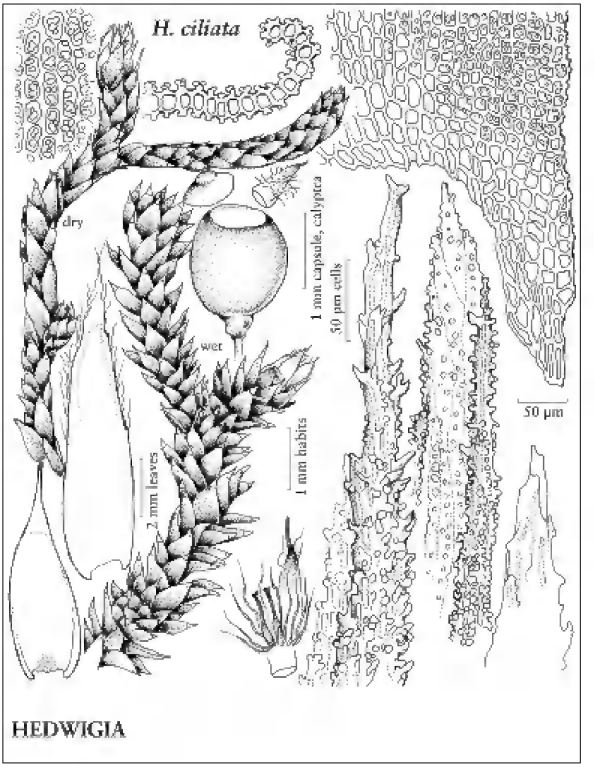
HEDWIGIA P.-Beauv., Mag. Encycl. 5: 304. 1804, name conserved. (Hedwigiaceae)

Hedwigia ciliata (Hedw.) P.-Beauvois, Prodr. Aethéogam., 15. 1805.
Anictangium ciliatum Hedw., Sp. Musc. Frond., 40. 1801.
Hedwigia ciliata subsp. *subnuda* Kindb.

Wyoming (FNA Vol. 28, 2014). Hawk's Ranch, Albany County (*Nelson 7500*). This plant is very common just to the south, entering Wyoming only at the extreme southern edge, Porter (1937).

Crook Co.: 4350 feet, *Porter 1676* (RM, BUF).

Helodium blandowii F. Weber & D. Mohr = Elodium blandowii (F. Weber & D. Mohr) Eckel



Courtesy FNA Association, FNA 28, 2014

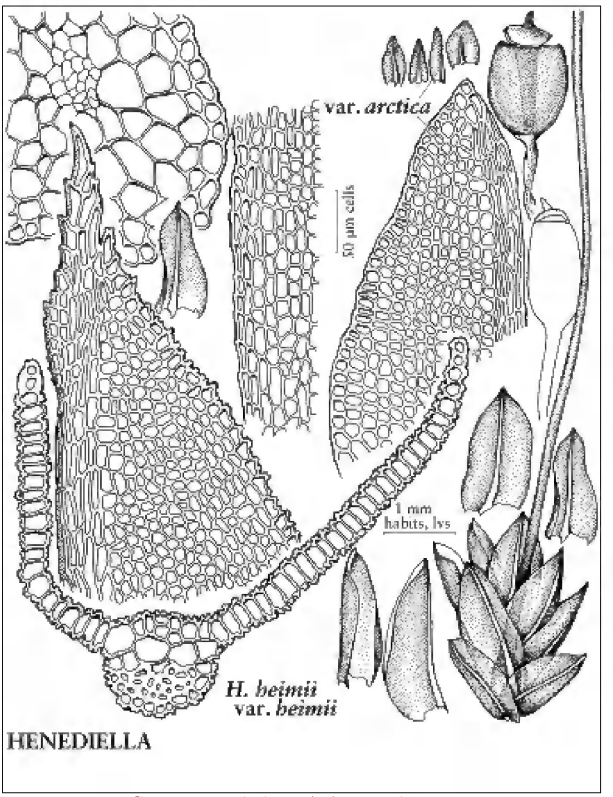
HENNEDIELLA Paris, Actes Soc. Linn. Bordeaux, sér. 5, 9: 232. 1895. (Pottiaceae)
Hennedia R. Brown bis, Trans. & Proc. New Zealand Inst. 25: 285. 1893, not *Hennedya* Harvey 1855.

Hennediella heimii (Hedw.) R.H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 248. 1993.
Gymnostomum heimii Hedw., Sp. Musc. Frond., 32. 1801.
Desmatodon heimii (Hedw.) Mitt.
Pottia heimii (Hedw.) Fürnr.
Pottia heimioides Kindb. in Macoun

Wyoming (FNA Vol. 27, 2007). (As *Desmatodon heimii*) British Columbia, Washington, Alberta, Idaho, Montana, Wyoming; Alaska, Yukon, California, Nebada, Utah, New Mexico, Colorado; Saskatchewan, Manitoba; Quebec, New Brunswick. (All as *Desmatodon heimii*) Antelope Basin, Albany Co. (*Nelson 7485*), (Sublette cos.), Porter (1935). (as var. *cylindrica* Br. Centennial, Albany Co. (*Nelson 7976*); Plumbago Canyon, Albany County (*Porter 490*), Porter (1935). (As *Pottia heimioides* Kindb. Centennial, Plumbago Canyon, and Libby Creek, all in Albany County; Pinedale, Sublette County, Porter (1935). ? var. *cylindrica* Br. in Porter (1935). Sublette Co.: Eckel (1985).

(All as *Desmatodon heimii*) Albany Co.: *Nelson 7484b,* with *Rosulabryum capillare* specimen, exsiccat (RM); Centennial, *Nelson 7976* (RM); NW base of Sheep Mtn along WY 11, seep area (calcareous fen) with *Populus, Betula*, and *Salix, Buck 23239* (NY); young skinny green capsules and old year, probably ripen at end of month, in packet of *Bryum caespiticium,* 7 Jun 1993, *Nelson 1538* (RM); Cummins, with *Funaria hygrometrica*, ca. 4 air mi ESE of Centennial, NW base of Sheep Mountain along WY 11, 7700–7900 ft, *Populus, Betula*, and *Salix* associated with spring seep, on soil bank, with *Leptobryum pyriforme* and *Campylium chrysophyllum,* 7 Jun 1993, *Miller 10,269* (NYS). Sweetwater Co.: ca. 6400 ft on US (187)191, at 14-Mile Reservoir picnic area in *Artemisia* scrubland, moist shaded ravine over brook, with *Leptobryum pyriforme* and *Campylium chrysophyllum*, 5 Jul 1985, *Eckel 412086* (BUF, RM).

There is also a (*Desmatodon heimii*) var. *arctica* (Lindb.) Crum = *Hennediella heimii* var. *arctica* (Lindb.) R.H. Zander, which is not in Wyoming (FNA Vol. 27, 2007).



Courtesy FNA Association, FNA 27, 2007

HETEROCLADIUM Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 151, plates 479, 480. 1852. (Pterigynandraceae)

Heterocladium dimorphum (Brid.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 153. 1852.
Hypnum dimorphum Brid., Muscol. Recent., suppl. 2: 149. 1812.
Heterocladium squarrosulum (Voit) Lindb.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Yellowstone Natl Park: along Firehole River near Old Faithful Geyser, rotten wood, 6 Jul 1934, *Frye s.n.* (BUF).

HOMALOTHECIUM Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 91, plates 456, 457. 1851. (Brachytheciaceae)
Camptothecium Schimp.
Camptothecium sect. Trachybryum Broth.
Trachybryum (Broth.) W.B. Schofield

Sometimes *Brachythecium salebrosum* can be deeply and multiplicate, resembling a species of *Homalothecium*. However, all species in *Homalothecium* are dioicous. The three species of the genus in Wyoming have no (or seldom have) recurved teeth near the leaf base (although the margins may be denticulate), the basal laminal cells are in only 1–3(–5) rows (not 5–8 rows) and the distal laminal cells on the abaxial surface of the leaf are smooth (not prorate). They are regularly (not unequally) pinnate and the branch leaves, when dry, are generally appressed (not erect and somewhat spreading).

Homalothecium aeneum (Mitt.) Lawton, Bull. Torrey Bot. Club 92: 351. 1965.
Hypnum aeneum Mitt., J. Linn. Soc., Bot. 8: 31, plate 5 (lower left). 1864.
Camptothecium aeneum (Mitt.) A. Jaeg.
Camptothecium aeneum subsp. *dolosum* Ren. & Card.
Camptothecium aeneum var. *dolosum* (Ren. & Card.) Grout
Homalothecium nevadense var. *aeneum* (Mitt.) Heike Hofmann

Wyoming; "The ranges of both taxa (plus *H. nevadense*) are almost identical, although *H. aeneum* is more common in the northern part of their range and *H. nevadense* in the south. The two species are distinguished mainly by sporophytic characters, and sterile collections are usually difficult to interpret" (Ignatov, FNA Vol. 28, 2014). (As *Camptothecium*) Albany County, Carbon County, Crook County, and Yellowstone Natl Park, Porter (1935). (As *Camptothecium aeneum*) Albany, Catron, Crook, Sheridan cos., Yellowstone Natl Park, Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: thin soil over dry, shaded rock under open canopy of Douglas fir, at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990 *Elliott 1791* (BUF). Sheridan Co.: *Rollins 362* (RM). Yellowstone Natl Park: Mammoth Hot Springs, Yellowstone Park, on moist ground, *Nelson 6041*, printed label Plants of Wyoming (US, RM).

The Mammoth Springs specimen Nelson 6041 was determined by Holz. as *Camptothecium lutescens* B.&S. (= *Homalothecium fulgescens*), but I have redetermined it as *H. aeneum* based on leaves only to 2 mm, many leaves broadly acute, short capsule (endostome probably eroded) and abundant (exsiccat) material on soil, not on trees as is typical of *H. fulgescens* (Lawton).

Homalothecium aureum (Spruce) H. Robinson, Bryologist 65: 96. 1963.
Isothecium aureum Spruce, Musci Pyren., 145. 1847.
Camptothecium amesiae Ren. & Card.
Homalothecium pinnatifidum (Sull. & Lesq.) Lawton

(As *Camptothecium pinnatifidum*) Mammoth, Yellowstone Natl Park (*Smiley*), Porter (1935). (As *Camptothecium pinnatifidum* (Sull. & Lesq.) A. Jaeg. & Sauerb). Yellowstone Natl Park, Porter (1937).

(As *Homalothecium pinnatifidum*) Sheridan Co.: moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 34, with *Ditrichum capillaceum, Hypnum pretense, McKee 92–001* (BUF, RM).

"The species can be recognized in the field by numerous, slightly curved branches that are conspicuously equal in length, and have closely julaceous foliage. The main microscopic diagnostic feature is the numerous quadrate alar cells, each relatively large, having clear outlines and only slightly incrassate walls, and arranged in rows parallel to the leaf margins." (Ignatov in (FNA Vol. 28, 2014).

[*Homalothecium lutescens* (Hedw.) H. Robinson (synonym: *Camptothecium lutescens* (Hedw.) Schimp. in B.S.G.) is a Eurasian species (Ignatov, FNA Vol. 28, 2014), excluded]

(As *Camptothecium lutescens* (Huds.) B. & S.) Yellowstone Natl Park, Porter (1937). Excluded from the North American flora by Crum et al., 1973. (As *Camptothecium lutescens*) Mammoth Hot Springs, Yellowstone Natl Park (*Aven & Elias Nelson 6041*), Porter (1935). The specimen, upon reexamination, is apparently *Homalothecium fulgescens* (Mitt. ex Müll. Hal.) A. Jaeg..)

Homalothecium nevadense (Lesq.) Ren. & Card., Bot. Gaz. 13: 202. 1888.
Hypnum nevadense Lesq., Mem. Calif. Acad. Sci. 1: 33. 1868.
Homalothecium nevadense var. *subulatum* Ren. & Card.
Homalothecium sericeoides Müll. Hal. & Kindb. in Macoun

Wyoming (FNA Vol. 28, 2014). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: granite outcrop on bank of Crandall Creek, 6500 ft, Shoshone Natl. Forest, 36 mi NW of Cody, *Hermann 20038* (US); dry, shaded rock under open canopy of Douglas fir, at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1783* (BUF).

This specimen (Elliott 20038) is identified without capsules. A sheet with several specimens of this species, none with capsules, was seen from US and identified by Lawton and Hermann. They were able to do this because *Homalothecium nevadense* is generally pinnatifid. Lawton (1971) does not mention any particular pinnate branching. The Park Co. specimen had smooth costae. Note that the basal angles were somewhat excavate and decurrent. See a great description by Flowers (1973: 455).

Homalothecium nitens (Hedw.) Robins. = Tomentypnum nitens (Hedw.) Loeske

Homalothecium pinnatifidum (Sull. & Lesq.) Lawton = Homalothecium aureum (Spruce) H. Robinson

HYGROAMBLYSTEGIUM Loeske, Moosfl. Harz., 298. 1903, name conserved. (Amblystegiaceae)

Hygroamblystegium noterophilum (Sull. & Lesq.) Warnst. = Hygroamblystegium varium subsp. noterophilum (Sull. & Lesq.) Vanderpoorten & Hedenäs

Hygroamblystegium tenax (Hedw.) Jenn. = Hygroamblystegium varium (Hedw.) Mönk. var. varium

Hygroamblystegium varium (Hedw.) Mönk., Hedwigia 50: 275. 1911 (as Hygramblystegium).
Leskea varia Hedw., Sp. Musc. Frond., 216, plate 53, figs. 15–20. 1801.
Amblystegium varium (Hedw.) Lindb.

Subsp. **varium** (Amblystegiaceae)

(As *Amblystegium varium*) Wyoming: Yellowstone Natl Park (*1533*) (Roell 1893). (As *Amblystegium varium* (Hedw.) Lindb.) Ferris Mts., Carbon Co. (*Nelson 4979*) Porter (1935). (As *Amblystegium varium* (Hedw.) Lindb.)

Albany Co.: 8500 ft, *Hermann 17776* (RM); Medicine Bow Mts, Medicine Bow Natl Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, *Pinus contorta* forest along Libby Creek, *Buck 23205* (NY).

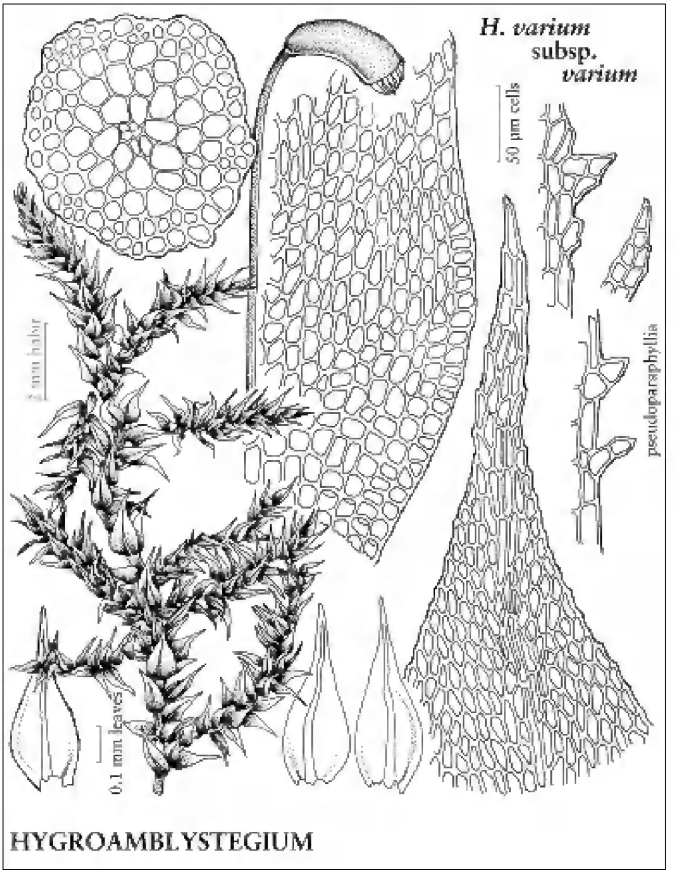
The *Hermann 17776* specimen has decidedly serrate margins and somewhat inflated alar cells. The Buck 23205 specimen has serrate margins, especially at the base, evidence of channeling in the acumen but with marvelously inflated excavate basal cells!

Subsp. **varium** var. **varium** (Amblystegiaceae)
Amblystegium fluviatile (Hedw.) Schimp.
Amblystegium tenax (Hedw.) C.E.O. Jensen
Amblystegium trichopodium (Schultz) Hartman
Hygroamblystegium fluviatile (Hedw.) Loeske
Hygroamblystegium humile (P.-Beauv.) Vanderpoorten, Hedenäs & Goffinet
Hygroamblystegium irriguum (Hook. & Wils. ex Wils.) Loeske
Hygroamblystegium orthocladum (P.-Beauvois) Loeske
Hygroamblystegium tenax (Hedw.) C.E.O. Jensen

Wyoming (FNA Vol. 28, 2014). (As *Hygroamblystegium irrigum*) Pole Creek, Albany County (*Porter 661*), Porter (1935). (As *Hygroamblystegium irrigum* (Wils.) Loeske) Albany Co., Porter (1937). (As *Hygroamblystegium orthocladon* (P.-Beauvois) Grout). Canyon, Yellowstone Natl Park (*Smiley*), Porter (1935). Wyoming, Crum and Anderson (1981: 927).

Lincoln Co.: 6700 ft, *Hermann 25603* (RM).

There is a var. *spinifolium* (Schimp.) Jenn. in Anderson et al. (1990) checklist (of *Hygroamblystegium tenax*).



Courtesy FNA Association, FNA 28, 2014

Subsp. **varium** var. **humile** (P.-Beauv.) Vanderpoorten & Hedenäs, J. Bryol. 31: 131. 2009.
Hypnum humile P.-Beauv., Prodr. Aethéogam., 65. 1805.
Amblystegium trichopodium (Schultz) C.J. Hartm. var. *trichopodium*
Amblystegium trichopodium (Schultz) Hartm.
Amblystegium trichopodium var. *curvipes* (Schimp. in B.S.G.) Broth.
Amblystegium trichopodium var. *kochii* (Schimp. in B.S.G.) Lindb.
Leptodictyum humile (P.-Beauv.) Ochyra
Leptodictyum trichopodium (Schultz) Warnst.
Leptodictyum trichopodium var. *curvipes* (Schimp. in B.S.G.) Broth.
Leptodictyum trichopodium var. *kochii* (Schimp. in B.S.G.) Broth.

Wyoming (FNA Vol. 28, 2014). (As *Leptodictyum trichopodium* (Schultz) Warnst. var. *kochii* (B.S.G.) Broth.) Albany, Crook cos., Porter (1935) & 1937. (As var. *kochii*) Albany Co.: Centennial Valley, Nelson 2671 (RM).

(All as *Leptodictyum humile*) Albany Co.: NW base of Sheep Mtn. along WY Rte. 11, ca. 4 mi due ESE of Centennial, ca. 7700–7800 ft, fen with low forest of *Populus, Betula, Salix* in shallow water, a "hanging bog" on steep hillside, in the bog, 7 Jun 1993, *Reese 18177* (LAF); ca. 4 air mi ESE of Centennial, NW base of Sheep Mtn, along WY 11, 7700–7900 ft, *Populus, Betula,* and *Salix* associated with spring seep, on log under shrubs, 7 Jun 1993, *Miller 10,264* (NYS). Crook Co.: Sundance Creek, *Nelson 2233* (RM). Sublette Co.: Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, rocks, lush herbage, N slope, Hoback River valley, shaded sandstone rock, with *Saionia uncinata, Brachythecium salebrosum, Eurhynchiastrum pulchellum, Platydictya jungermannioides,* 5 Jul 1985, *Eckel 9612521* (BUF).

Apparently the difference between this species and *Amblystegium juratzkanum*—in forms of *trichopodium* where the costa goes only halfway up the leaf, the leaves to 1 mm—is in the character of the areolation. In *A. trichopodium* (now *Leptodictyum*, as one would guess) the leaf cells are longer, thinner walled and larger than the smaller, shorter, thicker-walled *A. juratzkanum*. There are specimens in which the leaves are identical except for the leaf cells. See the comparative areolations in Crum and Anderson (1981: 943). *Campylium hispidulum*, which is similar, differs by the more conspicuous dentition, the channeled apex, the more abruptly acuminate condition from a broader base, the more slender apex sometimes short-filiform often reflexed or bent backward. *Campylium chrysophyllum* is strongly channeled in the apex and with more strongly falcate leaf tips again more abruptly acuminate. The costa is stronger, more than 1/2 the leaf length.

Subsp. **noterophilum** (Sull. & Lesq.) Vanderpoorten & Hedenäs, J. Bryol. 31: 130. 2009.
Hypnum noterophilum Sull. & Lesq. in A. Gray, Manual ed. 2, 678. 1856.
Amblystegium fluviatile var. *noterophilum* (Sull. & Lesq.) Flowers
Amblystegium noterophilum (Sull. & Lesq.) Holz.
Hygroamblystegium noterophilum (Sull. & Lesq.) Warnst.

Wyoming (FNA Vol. 28, 2014). (As *Hygroamblystegium noterophilum* (Sulliv.) Warnst.) Albany Co., Porter (1937). (As *Hygroamblystegium noterophilum* (Sull.) Warnst.) Laramie, Albany County (*Nelson 9112*), Porter (1935).

Albany Co.: "Laramie," *Nelson 9112* (RM).

Mentioned by Crum and Anderson (1981: 924), where Wyoming is cited, and "Attached to calcareous rocks and usually submerged in shallow, running water, in springs or small streams, often in association with *Fissidens grandifrons*, at its best development in large, upwelling calcareous springs."

HYGROHYPNUM Lindb., Contr. Fl. Crypt. As., 277. 1873. (Amblystegiaceae)
Hygrohypnella Ignatov & Ignatova
Pseudohygrohypnum Kanda

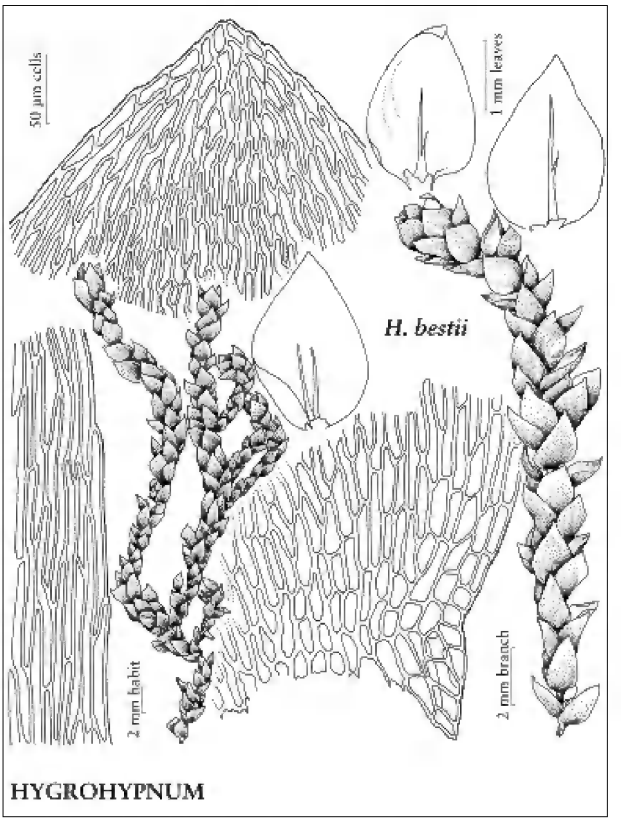
The species of *Hygrohypnum* may be occasionally confused with those of *Drepanocladus*: look for a variable costa in *Hygrohypnum*: double in *Hygrohypnum ochraceum* with large inflated auricles and cortical cells coming off from the stem.

Hygrohypnum bestii (Ren. & Bryhn) Holz., Bryologist 4: 12. 1901.
Hypnum molle subsp. *bestii* Ren. & Bryhn, Bull. Acad. Int. Géogr. Bot. 10: 7. 1901.
Hygrohypnella bestii (Ren. & Bryhn) Ignatov & Ignatova
Hygrohypnum bestii (Ren. & Bryhn) Broth.
Hygrohypnum molle var. *bestii* (Ren. & Bryhn) Habeeb
Limnobium bestii (Ren. & Bryhn) Holz.

Wyoming (FNA Vol. 28, 2014). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Fremont Co.: Dubois, westward near Tworoger Pass, 9000 ft, on ground, 22 Jun 1931 *Frye s.n.* (WTU). Park Co.: Rd from Bear Tooth Lodge to Red Lodge, E of Summit at 10,500 ft near small glacial lake, *Lawton 1972,* leaves to 2 mm (WTU). Park Co.: Falls Creek near Silver Gate, *Lawton 2118* (WTU); NW side of Bear Tooth Lake, *Lawton 2079* (WTU). Teton Co.: Teton Natl Park, Cascade Trail, 14 Aug 1953, *Lawton 1769* (WTU). Yellowstone Natl Park: Mt. Washburn, 16 Aug 1925, *Frye s.n.* (RM); Black Sand Basin, with *Bryum pseudotriquetrum, Calliergonella cuspidate,* 18 Aug 1953, *Lawton 1871* (WTU).

These specimens are only identified as *Hygrohypnum bestii* because some stem tips support leaves to 2 mm, but none of them by much more. Jamieson (in FNA Vol. 28, 2014) considered this a western species with some eastern disjuncts. "*Hygrohypnum bestii* is much confused in North America with *H. duriusculum* and *H. molle*; plants are readily distinguished by their diagnostically long marginal laminal cells, to 90 µm or longer" (Jamieson in FNA Vol. 28, 2014).



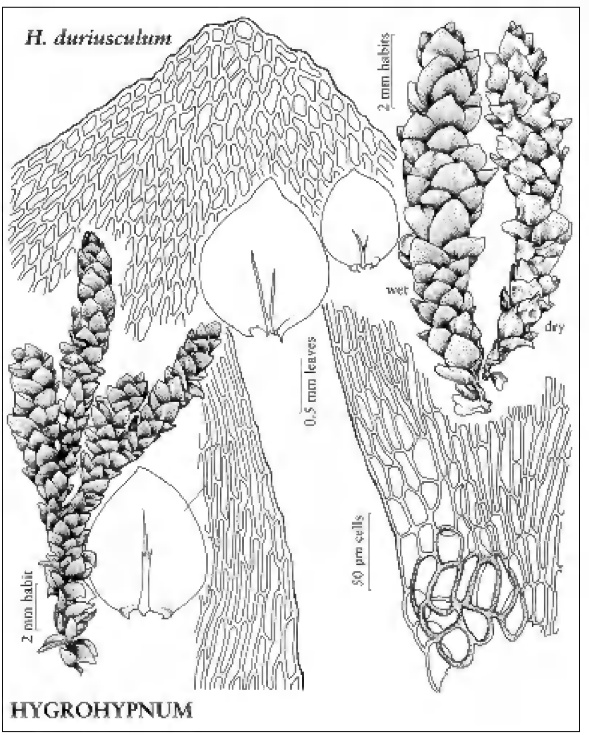
Courtesy FNA Association, FNA 28, 2014

Hygrohypnum dilatatum (Wils.) Loeske = Hygrohypnum molle (Hedw.) Loeske

Hygrohypnum duriusculum (De Not.) D.W. Jamieson, Taxon 29: 152. 1980.
Limnobium duriusculum De Not. in F. Ardissone et al., Erb. Crittog. Ital., ser. 2: no. 204. 1869.
Calliergon circulifolium (Müll. Hal. & Kindb.) Kindb.
Calliergon dilatatum (Wilson) Kindb.
Calliergon pseudoarcticum (Kindb.) Kindb.
Hygrohypnella duriuscula (De Not.) Ignatov & Ignatova
Hygrohypnum dilatatum (Wilson) Loeske
Hygrohypnum eugyrium var. *dilatatum* (Wilson) Grout
Hypnum circulifolium Müll. Hal. & Kindb.
Hypnum dilatatum Wilson
Hypnum pseudoarcticum Kindb.
Limnobium pseudoarcticum (Kindb.) Kindb.
Ochyraea duriuscula (De Not.) Ignatov & Ignatova

Wyoming (FNA Vol. 28, 2014)

(As *Hygrohypnum duriusculum*) Sublette Co.: 10,324 ft, *Rolston 85106* (CSU).



Courtesy FNA Association, FNA 28, 2014

Hygrohypnum luridum (Hedw.) Jennings, Man. Mosses W. Pennsylvania, 287. 1913.
Hypnum luridum Hedw., Sp. Musc. Frond., 291. 1801.
Calliergon pseudomontanum (Kindb.) Kindb.
Hygrohypnum palustre (Hedw.) Loeske
Hygrohypnum palustre var. *julaceum* (Schleicher ex P. Bruch & Schimp.) Loeske
Hygrohypnum palustre var. *subsphaericarpon* (Schleicher ex Brid.) Loeske
Hygrohypnum pseudomontanum (Kindb.) Grout
Hypnum columbicopalustre Müll. Hal. & Kindb.
Hypnum palustre Hudson ex Brid.
Hypnum pseudomontanum Kindb.
Hygrohypnum palustre Loeske, nom. illeg.
Hypnum subeugyrium var. *occidentale* Card. & Thériot
Limnobium pseudomontanum (Kindb.) Kindb.
Scleropodium krausei (Müll. Hal.) Macoun & Kindb.

(As *Hygrohypnum palustre* (Huds.) Loeske. Battle Lake, Carbon County (Nelson 4202, in part); Elk Mountain, Carbon County (Goodding, 548), Porter (1935). (As *Hygrohypnum palustre* Loeske.) Carbon Co., Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

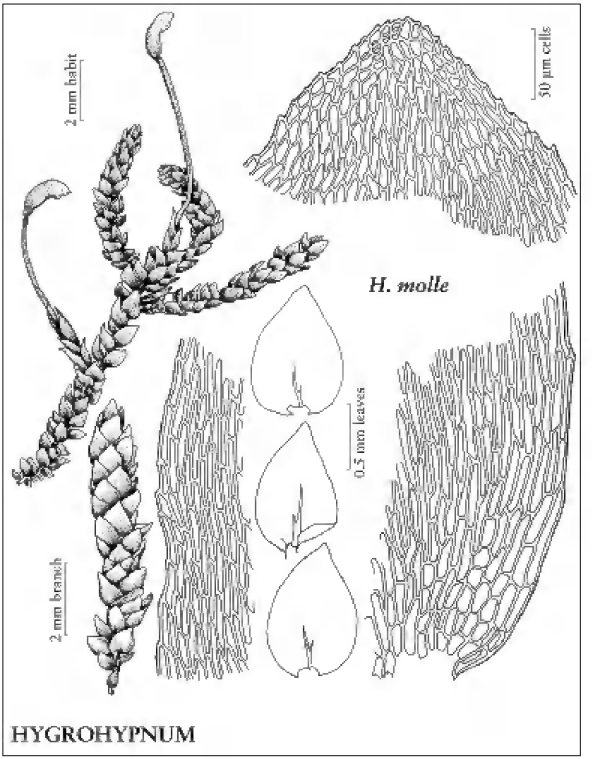
Albany Co.: Medicine Bow Mtns., Medicine Bow Natl. Forest, Barber Lake Picnic Area, 2.5 air mi NW of Centennial, *Pinus contorta* forest along Libby Creek, 2660 m, *Buck 23199* (NY); Centennial Hills, 20 Aug 1896, *Nelson 2704*. Carbon Co.: Medicine Bow Range on the Sand Lake road at Trail Creek, 9200 ft, spruce-fir zone, submerged in stream, 11 Aug 1964. *Porter 9695* (RM). Lincoln Co.: 6600 ft, stones, partially submerged, *Hermann 25592* (RM). Natrona Co.: Hat Six Falls, 7 Aug 1898, *Nelson 5038* (RM). Sublette Co.: 7950 ft, moist boulder, *Hermann 25338* (RM). Yellowstone Natl Park: wet creek-boulder, *Hermann 25769* (RM).

The plants (e.g. *Buck 23199*) do indeed manage to not be denticulate in the apex, as in *Hygrohypnum molle* and *H. bestii*. The plants are "lurid," a sordid dark green to yellow with brown tones overall. The leaf shape is distinctive: short rice-shaped; boat or spoon shaped (concave), rather than orbiculate as in *H. molle* and *H. bestii*. The leaves are broadest across the middle. "*Hygrohypnum luridum* is the only calcicole in the genus; it occurs on calcareous rock or on other substrates irrigated with calcareous water" (Jamieson in FNA Vol. 28, 2014).

Hygrohypnum molle (Hedw.) Loeske, Moosfl. Harz., 320. 1903.
Hypnum molle Hedw., Sp. Musc. Frond., 273, plate 70, figs. 7–10. 1801.
Calliergon molle (Hedw.) Kindb.
Calliergon submolle (Kindb.) Kindb.
Hygrohypnum dilatatum (Wils.) Loeske
Hygrohypnum smithii var. *goulardii* (Schimp.) Wijk & Marg.
Limnobium submolle Kindb.
Ochyraea mollis (Hedw.) Ignatov

Not reported from Wyoming in FNA (FNA Vol. 28, 2014). (As *Hygrohypnum dilatatum* (Wils.) Loeske). Carbon County and Johnson County, Porter (1935). Carbon, Fremont, Johnson, Teton cos., Yellowstone Natl Park, Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: University Laboratory near Centennial, *Lawton 1657,* leaves to 1.5 mm (WTU). Carbon Co.: moist soil on rocks, 10,000 ft, *Hermann 17148* (RM) Park Co.: Beartooth Plateau, snowbeds, 3200 m, *Weber B–44313* (RM, COLO). Yellowstone Natl Park: near mouth of Yellowstone Lake, 21 Jun 1931, *Frye s.n.*, leaves to 1 mm (WTU).



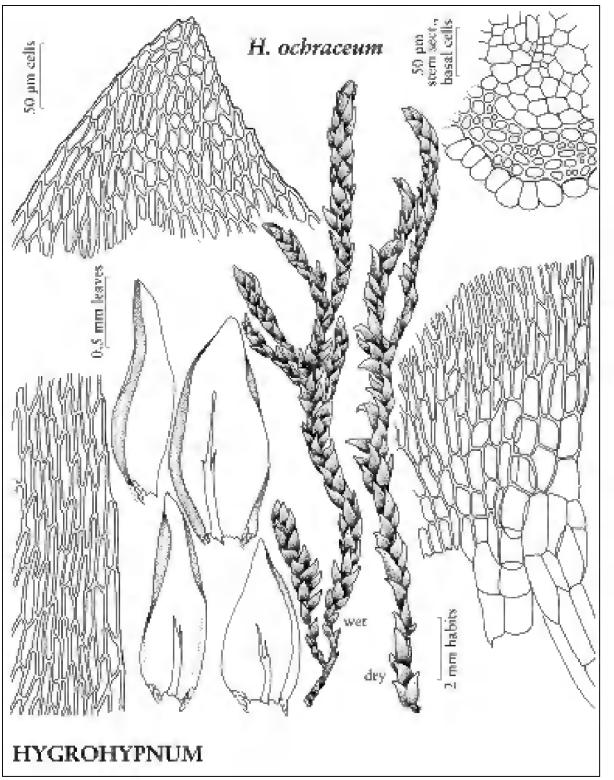
Courtesy FNA Association, FNA 28, 2014

Hygrohypnum ochraceum (Turner ex Wilson) Loeske, Moosfl. Harz., 321. 1903.
Hypnum ochraceum Turner ex Wilson, Bryol. Brit., 400, plate 58 (lower right).
Calliergon ochraceum (Turner ex Wilson) Kindb.
Hygrohypnella ochracea (Turner ex Wilson) Ignatov & Ignatova
Hygrohypnum ochraceum var. *filiforme* (Limpr.) J.J. Amann
Hygrohypnum ochraceum var. *flaccidum* (Milde) J.J. Amann
Hygrohypnum ochraceum var. *uncinatum* (Milde) Loeske

Wyoming (FNA Vol. 28, 2014). (As *Hypnum ochraceum*) Wyoming: Yellowstone Natl Park (*1568–69, 1572a*) (Roell 1893). Pole Mt., Albany County (*Porter 1418*); Canyon, Yellowstone Natl Park (*Smiley*), Porter (1935); Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Carbon Co.: 25 Jun 1931, *Frye s.n.* (RM); wet rocks on edge of stream above Lake Marie, 10,000 ft, Snowy Range, Medicine Bow Mts., ca. 13 mi E of Ryan Park, 19 Aug 1961, *Hermann 17149* (RM). Carbon Co.: 8600 ft, creek bank, *Hermann 26714* (RM). Fremont Co.: 8600 ft, partially wooded slope, *Hermann 25306* (RM); westward from Dubois, Tworoger Pass, about 9000 ft, 22 Jun 1931, *Frye s.n.* (BUF). Sublette Co.: 10,324 ft, *Rolston 85136* (CSU); 10,500 ft, *Rolston 85116* (CSU); 10,595 ft, *Rolston 85107* (CSU); Bridger Wilderness, Wind River Range, Barnes Lake,

9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May 1989, *Andrus 7792a* (BING). Yellowstone Natl Park: 7 Jul 1934, *Frye s.n.* (RM).

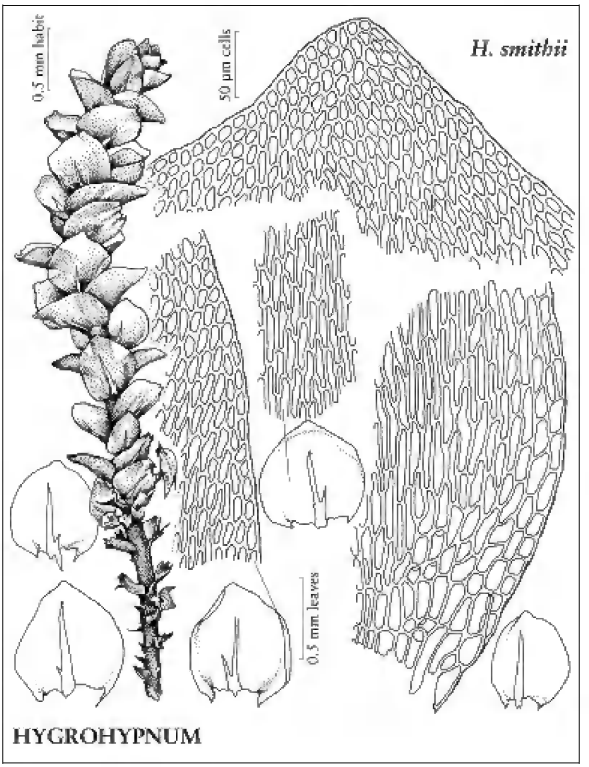


Courtesy FNA Association, FNA 28, 2014

Hygrohypnum smithii (Sw.) Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 231(I,3): 1039. 1908.
Leskea smithii Sw. in S. Liljeblad, Utkast Sv. Fl. ed. 3, 549. 1816.
Calliergon arcticum (Sommerfelt) Kindb.
Hypnum torrentis Müll. Hal. & Kindb.
Ochyraea smithii (Sw.) Ignatov & Ignatova

Not reported for Wyoming by FNA (FNA Vol. 28, 2014). Centennial, Albany County (Nelson 2704). "This was published as *Hypnum arcticum* in the report by Dr. Nelson (1900)," Porter (1935). Albany Co., Porter (1937). I have redetermined that specimen as *H. luridum*.

Sublette Co.: Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 42°59'N, 109°34'W, on rocks along stream, 10,240 ft, 16 May 1989, *Andrus 7843* (BING).



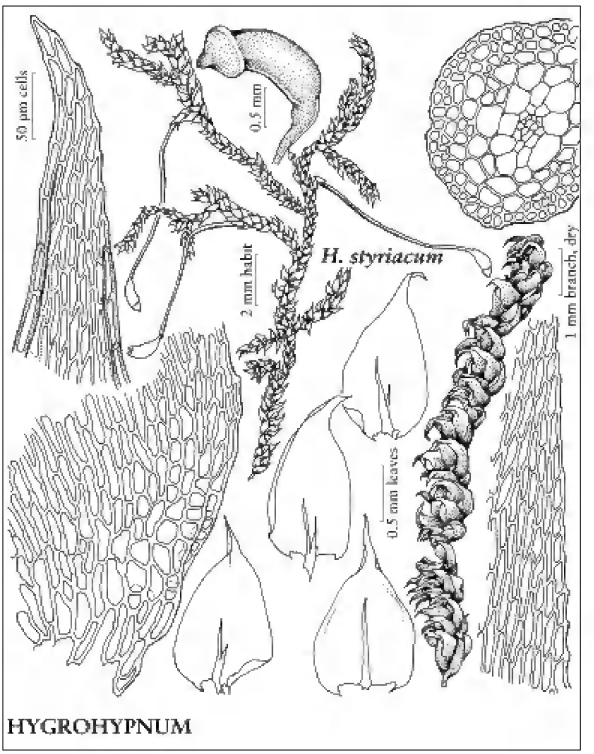
Courtesy FNA Association, FNA 28, 2014

Hygrohypnum styriacum (Limpr.) Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 231(I,3): 1039. 1908.
Hypnum styriacum Limpr., Flora 65: 201. 1882.
Eurhynchium styriacum (Limpr.) Kindb.

Wyoming (FNA Vol. 28, 2014).

Park Co.: SNF, Beartooth Plateau: Beartooth Creek, granite debris along the creek, attached to boulders periodically wet by spray and seasonally covered with fast flowing water, associated with *Scouleria aquatica*, T57N R105W S7, 44°36.270–280 N, 109° 36.010–020'W, ca. 8900 ft (2700 m), 23 Aug 2009, *Kosovich-Anderson 5431* (COLO); also Beartooth Lake, W and SW shore, *Picea engelmannii* forest along the shore, on wet clay, associcated with *Sanionia uncinata, Calliergonella cuspidata*, T57N R105W S6&7, 44°56.500–520'N, 109°35.980–990'W, 2700 m, 24 Jul 2010 *Kosovich-Anderson 6652* (no herb. cited) (also cited by Kosoviich-Anderson & Weber 2011).

Hygrohypnum smithii var. goulardii (Schimp.) Wijk & Marg. = Hygrohypnum molle (Hedw.) Loeske



Courtesy FNA Association, FNA 28, 2014

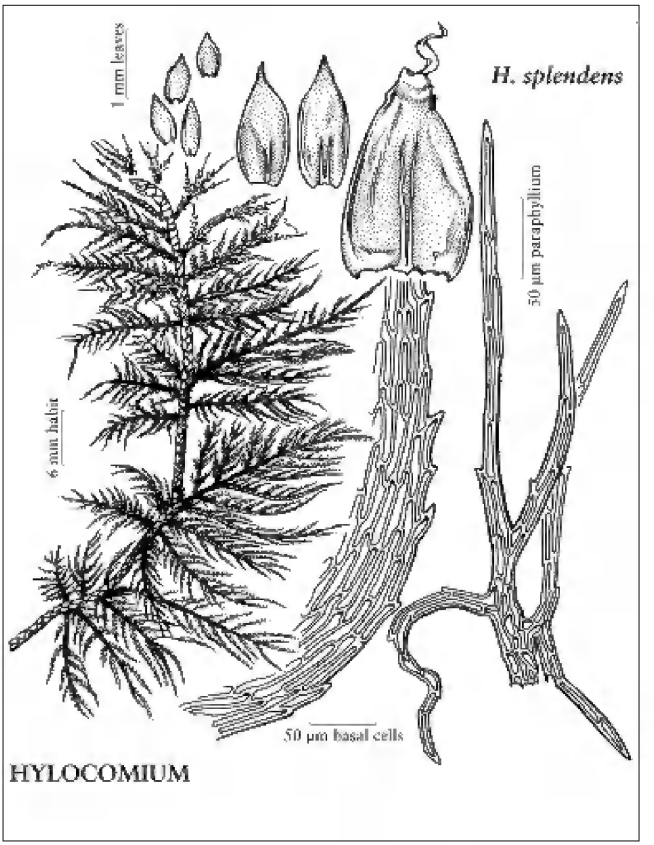
HYLOCOMIUM Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 169, plates 487–493. 1852. (Hylocomiaceae)

Hylocomium splendens (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 173. 1852.
Hypnum splendens Hedw., Sp. Musc. Frond., 262, plate 67, figs. 6–9. 1801.
Hylocomium alaskanum (Lesq. & James) Aust.
Hylocomium proliferum (Brid.) Lindb.
Hylocomium splendens var. *alaskanum* (Lesq. & James) Limpr.
Hylocomium splendens var. *compactum* (Lesq. & James) Macoun & Kindb.
Hylocomium splendens subsp. *giganteum* Vitt
Hylocomium splendens var. *obtusifolium* (Geheeb) Paris
Hypnum proliferum Brid.

Wyoming (FNA Vol. 28, 2014). In Park Co. *Hylocomium splendens* forms a rich bryophyte community combined with *Aulacomnium palustre, Climacium dendroides, Helodium blandowii, Rhizomnium* spp., *Thuidium recognitum, Marchantia alpestris*, (*Thuidium recognitum*, q.v.) and others" (Kosovich-Anderson & Weber 2011). (As *Hylocomium proliferum* (Brid.) Lindb.) Sheridan

County and Yellowstone Natl Park, Porter (1935). Johnson, Sheridan cos., Yellowstone Natl Park, Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: Wolf Creek Canyon, *Nelson 2306* (RM).



Courtesy FNA Association, FNA 28, 2014

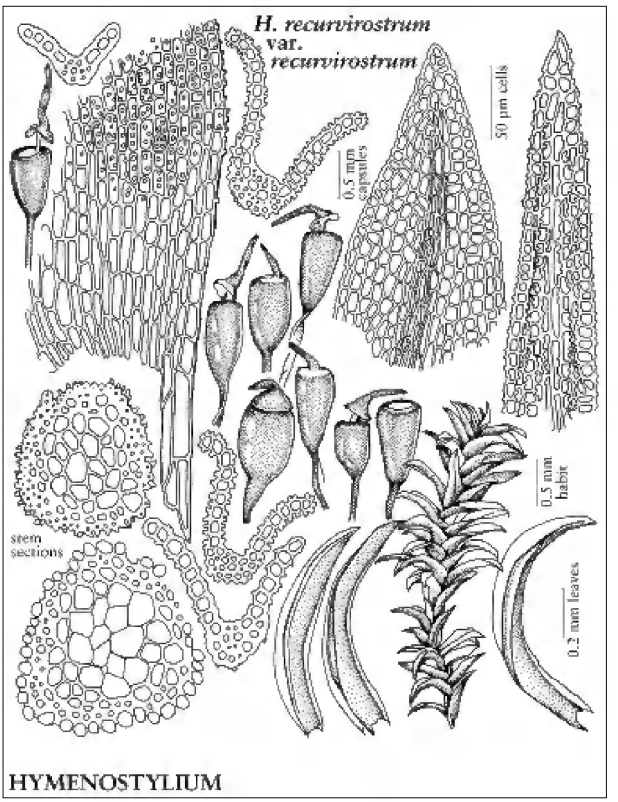
HYMENOSTYLIUM Brid., Bryol. Univ. 2: 81. 1827. (Pottiaceae)

Hymenostylium recurvirostrum (Hedw.) Dixon, Rev. Bryol. Lichénol., n. s. 6: 96. 1934.
Gymnostomum recurvirostrum Hedw., Sp. Musc. Frond., 33. 1801.
Barbula curvirostris fo. *scabra* Lindb.
Gymnostomum recurvirostre var. *scabrum* (Lindb.) Grout
Hymenostylium recurvirostre (Hedw.) Dix.
Weisia curvirostris (Hedw.) Müll. Hal.

Var. **recurvirostrum** (Pottiaceae)

Wyoming (FNA Vol. 27, 2007). British Columbia, Washington, Alberta, Idaho, Montana, Wyoming; Alaska, Nevada, Utah; South Dakota, Iowa, Missouri, Minnesota, Wisconsin, Ontario; New England, New York, Virginia, North Carolina. (As *G. curvirostra* (Ehrh.) Hedw.) Point of Rocks, Sweetwater Co. (*Nelson 8144*); South Butte, Sweetwater Co. (*Nelson 3549*), Porter (1935).

Albany Co: Medicine Bow Mts., E of Snowy Range Pass, 10 Aug 1953, *Lawton 1663* (WTU). Johnson Co.: 6600 ft, *Nelson 6836a* (RM). Natrona Co.: Hat Six Falls, SE of Casper, 7 Aug 1897, *Nelson 5036* (RM), with *Pseudoleskeella tectorum*. Park Co.: 8600–9000 feet, *Hartman 13131* (RM, BUF). Sweetwater Co.: *Nelson 3549* (RM); on the abrupt face of cliff wet with sulphur water, Point of Rocks, *Nelson 8144* (COLO, WTU).



Courtesy FNA Association, FNA 27, 2007

HYPNUM Hedw., Sp. Musc. Frond., 236, plate 59, figs. 8, 9; plates 60–77. 1801, name conserved (Hypnaceae)
Stereodon (Brid.) Mitt.

If you have what seems apparently a *Hypnum* that has erect capsules, erect or straight leaves and is otherwise *Hypnum*-like, even to the little quadrate cells in the leaf angles, you have probably got *Pylaisiella*, probably *P. polyantha*. *Pylaisiella* species are, additionally, autoicous.

[*Hypnum callichroum* Funck. ex Brid. Evanston, Uinta County (Nelson 4128, in part (see *H. Lindb.ii*). "The identity of this plant is doubtful," Porter (1935). Uinta Co., Porter (1937), excluded.]

Hypnum cupressiforme Hedw., Sp. Musc. Frond., 291. 1801.
Stereodon cupressiformis (Hedw.) Mitt.

Not reported for Wyoming according to FNA (FNA Vol. 28, 2014), as neither the var. *cupressiforme* nor its other varieties. Albany County (*Porter 668 & 1279*), Porter (1935). (As *Hypnum vaucheri* Lesq.) Lawton. Albany Co., Porter (1937). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, (Spence 1981). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: limestone rock, deep crack, 19 Mar 1988, *Vukelich s.n.* (BUF); Laramie Mtns., Roger Canyon, ca. 8 air mi NE of Laramie, Co. Rd. 17, limestone outcrops with *Cercocarpus montanus, Buck 23164,* this may be *H. vaucheri*, see Reese specimen below (NY). Sheridan Co.: limestone boulder in spruce-fir forest, Big Horn Natl Forest, T57N, R89W, Sect. 34, with *Dicranoweisia crispula, Tortella tortuosa, Tortula norvegica,* 19 Jun 1992, *McKee 92-F4,* c.fr. (RM).

There are vars. *filiforme* Brid., var. *julaceum* Brid., var. *lacunosum* Brid., var. *resupinatum* (Tayl.) Schimp. in Spruce and var. *subjulaceum* Mol. in the Anderson et al. (1990) checklist.

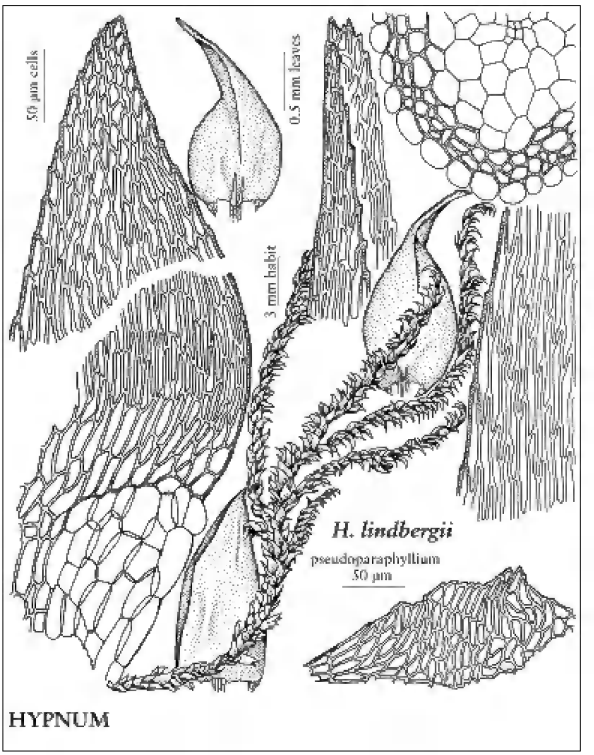
(As var. *resupinatum* a variety not mentioned by Schofield in FNA Vol. 28, 2014): Hawk's Ranch, Colorado-Wyoming State line, Albany County (*Williams 98*), Porter (1935). Albany Co., Porter (1937).

Hypnum lindbergii Mitt., J. Bot. 2: 123. 1864.
Hypnum arcuatum Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 18: 371. 1862, not Hedw. 1801.
Calliergonella lindbergii (Mitt.) Hedenäs
Hypnum arcuatum var. *americanum* Ren. & Card.
Hypnum arcuatiforme Kindb.
Hypnum Renaulii Kindb.
Stereodon patientiae Lindb.

Wyoming (FNA Vol. 28, 2014). (As *Hypnum arcuatum* Lindb.) Albany County (Porter 770, 780, 1443; and Nelson 8813), Porter (1935). (As *Hypnum arcuatum* Lindb.) Albany Co., Porter (1937). Teton Co., Spence (1985). Johnson Co., in association with *Warnstorfia tundrae* (Lenz 2006). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 11,000 ft, *Hermann 23430* (RM). Sublette Co.: Bridger Wilderness, Wind River Range 2, 14 May 1989 Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake with *Campyllium stellatum, Andrus 7801b* (BING). Uinta Co.: Evanston, 27 Jul 1897, *Nelson 4128,* cortical cells inflated, apex of leaves only acuminate, not filiform, falcate not circinate, inflated alar cells not rounded to insertion (RM)

May be confused with *Hygrohypnum ochraceum*, which has "less crowded leaves with acumina twisted and flexuose and much stronger costa" (Crum & Anderson 1981: 1173 (see discussion at *Drepanocladus*). For *H. lindbergii* cells across the insertion may be a nice orange color that may also affect the alar cells (which may appear thickened), which are usually hyaline, inflated. In Colorado (as *Calliergonella lindbergii*), the species is described as common "in willow carrs and along snow-melt streamlets in the subalpine" (Webber & Wittmann 2007). The leaves are strongly falcate, not complanate and the alar cells are in a clearly inflated group.



Courtesy FNA Association, FNA 28, 2014

Hypnum pallescens (Hedw.) P.-Beauvois, Prodr. Aethéogam., 67. 1805.
Leskea pallescens Hedw., Sp. Musc. Frond., 219, plate 55, figs. 1–6. 1801.
Hypnum depressulum Müll. Hal.
Hypnum pallescens var. *protuberans* (Brid.) Lesq. & James
Hypnum reptile Michx.
Stereodon pallescens (Hedw.) Mitt.

Wyoming (FNA Vol. 28, 2014). (As *Hypnum depressulum*) Albany County (*Nelson 5172, 1924*), Porter (1935). Albany Co., Porter (1935). (As *H. reptile* Michx.) Weston Co., Wynne (1943).

Albany Co: (As *Hypnum pallescens* (Hedw.) P.-Beauv.) La Plata Mines, 25 Aug 1898, *Nelson 5172* (RM); Laramie Hills, 13 Jun 1896, *Nelson 1924* (RM) .

Hypnum pratense Koch ex Spruce, London J. Bot. 4: 177. 1845.
Breidleria pratensis (Koch ex Spruce) Loeske
Hypnum pseudopratense Kindb.
Stereodon pratensis (Koch ex Spruce) Warnst.

Not yet reported for Wyoming according to FNA (FNA Vol. 28, 2014); the genus *Breidleria*, recognized by Weber and Wittmann (2007) in the Colorado flora, has been treated as *Hypnum* (FNA 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 34, with *Homalothecium pinnatifidum, Ditrichum capillaceum*, *McKee 92–001* (BUF, RM).

Easily confused with *Hypnum lindbergii* with which it shares many characteristics, such as the hyalodermis of inflated cells around the periphery of the stem cross Sect. (note stem central strand present in both species). *Hypnum lindbergii* has a significant area of inflated, lax, hyaline cells in the alar region of the leaf in distinctive decurrencies. That is not to say *Hypnum pratense* does not also have such inflated, lax and hyaline cells there, but they are less to insignificant or ambiguous, and usually mixed with the flaccid cells of the hyalodermis when stripped from the stem. The inflated cells may occur in only one or two to three rows. The leaves of *H. pratense* are not decurrent; the leaves are weakly falcate, whereas in *H. lindbergii* they are strongly so. In Colorado, the species (as *Breidleria pratensis*) is described as having stems "dorsiventrally compressed, the leaves complanate, in one plane and closely overlapping, not strongly falcate, slightly denticulate apically, the margins plane, alar cells not sharply delimited. It is inconspicuous and rarely collected, but expected to be frequent in willow carrs and wet tundra" (Weber & Wittmann 2007).

Hypnum revolutum (Mitt.) Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 23: 542. 1867.
Stereodon revolutus Mitt., J. Proc. Linn. Soc., Bot., suppl.: 97. 1859.

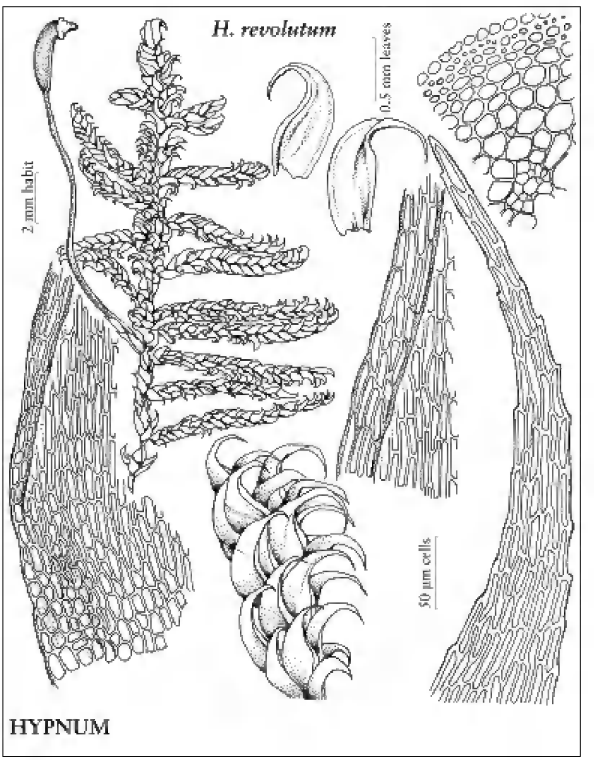
Var. **revolutum**

Wyoming (FNA Vol. 28, 2014). (As *Hypnum heufleri* Jur.) Wyoming: Yellowstone Natl Park (*1537–38, 1541, 1555*) (Roell 1893). "Very common." Albany County, Carbon County, Sublette County, Teton County, and Yellowstone Natl Park, Porter (1935). Albany, Carbon, Sublette, Teton cos., Yellowstone Natl Park, Porter (1935). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming (Spence 1981). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 9800 ft, *Hermann 23427* (RM); *Hermann 17752* (RM); Medicine Bow Mtns., Barber Lake picnic area, 2.5 mi due NW of Centennial, 8700 ft, *Pinus contorta* forest along Libby Creek, on boulder, 7 Jun 1993, *Reese 18168* (LAF). Big Horn Co.: just off US 16 between TenSleep & Buffalo (near Sitting Bull Campsite), *Pinus contorta* var. *latifolia* being lumbered, just N of Washakie Co. border, ca. 5000 ft, disturbed soil with *Bryum lisae* var. *cuspidatum*, *Ceratodon purpureus*, 6 Jul 1985 *Eckel 94092203* (BUF). Fremont Co.: 7800 ft, *Hermann 25535* (RM); soil on rock, Douglas fir slope 1/2 mi E of Horse Creek Campground, 7800 ft, Absaroka Range, 11 mi N of Dubois, 28 Aug 1973, *Hermann 25536* (RM). Park Co.: 6500 ft, *Hermann 20040* (RM); thin soil over dry, shaded rock under open canopy of Douglas fir, at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1792* (BUF). Sheridan Co.: limestone boulder in spruce-fir forest, Big Horn Natl Forest, T57N, R89W, Sect. 34, *McKee 92-F1* (BUF, RM).

Sublette Co.: 7850 ft, *Hermann 25318* (RM); Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, at base of trees by lake, 14 May 1989, *Andrus 7804* (BING); Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, wooded spruce bank, sandstone rocks, lush herbage, N slope, Hoback River valley, shaded sandstone rock, 5 Jul 1985, *Eckel 961259* (BUF, RM). Teton Co.: 7000 ft, *Hermann 25557* (RM). Yellowstone Natl Park: Bartley, *Pontious 7* (RM).

"Since the leaves tend to be strongly channeled, it is often difficult to observe whether the margin is actually revolute. I have often had to prove the point with cross Sect.s of the leaves" Flowers (1973: 513). The Big Horn Co. specimen (*Eckel 94092203*) is golden-green to brown as the descriptions indicate, rather than all green, as *H. pallescens* is said to be. The distribution of *Hypnum revolutum* var. *ravaudii* (Boulay) Ando is problematic as "The variety is troublesome to determine because of its lack of the characteristic revolute margins (except sometimes near the base), and the costa is difficult to discern" (Schofield in FNA Vol. 28, 2014).



Courtesy FNA Association, FNA 28, 2014

Hypnum vaucheri Lesq., Mém. Soc. Sci. Nat. Neuchâtel 3(3): 48. 1846.
Hypnum complexum (Mitt.) A. Jaeger & Sauerb.
Hypnum subcomplexum Kindb.
Stereodon vaucheri (Lesq.) Broth.

Wyoming (FNA Vol. 28, 20140). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Medicine Bow Mtns., Barber Lake picnic area, ca. 2.5 mi due NW of Centennial ca. 8700 ft, *Pinus contorta* forest along Libby Creek, on duff, *Reese 18169* (LAF); Laramie Mtns, Roger Canyon, 8 air mi NE of Laramie City center, 7850–8000 ft on soil, associated with limestone outcrop, 7 Jun 1993, *Miller 10,239* (NYS).

Hypnum vaucheri is a tiny plant, irregularly branched, subjulaceous, especially when wetted. One thinks of *H. revolutum*, but the margins are not recurved except a little at the base—they are erect on a concave leaf to inward, making the leaf tubulose to a channeled apex. Flowers (1973) gives a strikingly good description of the Reese specimen. He says *H. vaucheri* "is one of the dominant mosses in localized parts of the Colorado-Green River Basin, where it grows on dry rocks and ledges, often on sandy soil sheltered by overhanging rocks, bases of trees, shrubs and bunchgrasses. Elsewhere in the state it is less frequent." It is indeed, as he says, "brownish green and somewhat glossy when dry." It is also notable for its large area of quadrate cells, in well defined groups about twice as long as wide, to 15 cells up the leaf margin. Although the Reese specimen shows mostly secund-falcate leaves, these are variable to straight. This variability is distinctive. Paraphyllia are foliose!

IMBRIBRYUM N. Pedersen, Bryologist 108: 449. 2005. (Bryaceae)

[*Imbribryum alpinum* (Hudson ex Withering) N. Pedersen, Bryologist 108: 449. 2005 1801, excluded.]

Bryum alpinum Hudson ex Withering, Syst. Arr. Brit. Pl. ed. 4, 3: 824. 1801.

Not reported for Wyoming in FNA; its western distribution is Alaska, California, and Colorado; the species requires taxonomic revision (Spence, FNA Vol. 28, 2014). (As ?*Bryum alpinum* Huds. ex With.): Sheep Mountain, Albany Co. (*Goodding 2098*), Porter (1935).

(As *Bryum alpinum* Huds. ex With.): In one specimen from Europe, the red-orange and green color is evident, like the pink-green of *B. weigelii*, it is not of the ruby red variety: resembles a *Pohlia*. Basal cells seem thinner walled, more hyaline and in old or young leaves sort of auriculate. The leaf is bellied, concave, the margins broadly reflexed, and then tightly revolute on the extreme margins to below the apex. The costa is not or shortly percurrent and the apex broadly acute. Leaf cells are rectangular and broad. The lower stems are not covered with rhizoids such that they appear outside the leaves, so not "matted" but rather "clean-shaven", actually, and long and fine. The stem from Colorado showed a clear "year" difference, or at least two distinct growing periods with two different sets of leaves, the first period the leaves are brick red like the stem and more lanceolate and narrowly acute with percurrent costae. The second growth is fair green, more ovate (broadest across the middle), more broadly acute and the costae subpercurrent. The leaf cells more linear- rhomboidal and the walls robust to thick, the cells at the base becoming "bubbly," turgid and hyaline and thinner walled, quadrate, the central basal cells differentiated almost, conspicuously bigger below the belly of the leaf, rectangular than the upper median laminal cells (seen in older leaves). The belly of the leaf ends several cells below the apex of the leaf, leaving the apex flat. *Bryum alpinum* has entire leaves or minutely denticulate in apex; margins recurved nearly to the apex: more often acute, occasionally only, obtuse, costa of some leaves shortly *excurrent*. *Ptychostomum cyclophyllum*, a reddish moss with small, obtuse leaves is distinctive by its contorted leaves when dry; *B. gemmiparum*, which is also scarcely contorted, but it is said to not have reddish color except when old.

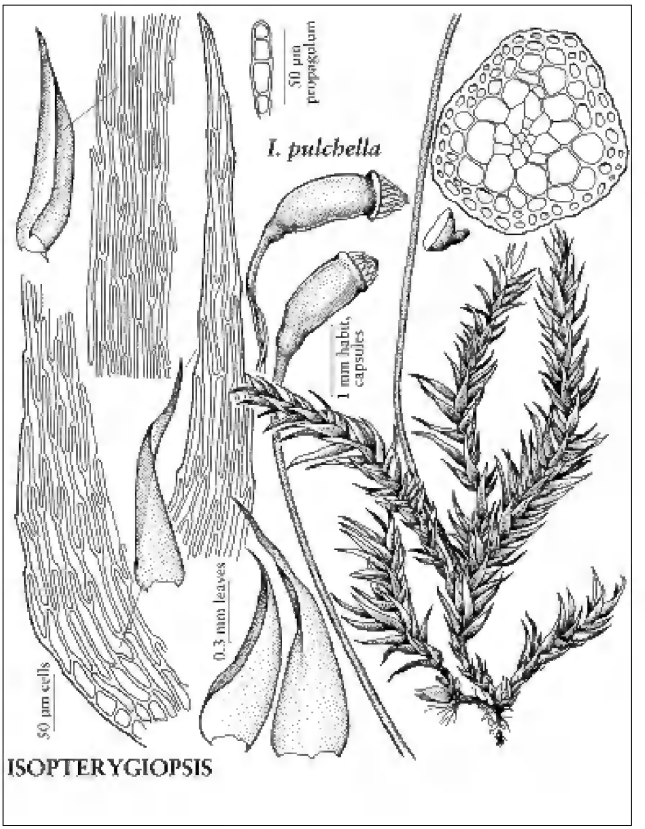
Imbribryum gemmiparum (De Not.) J.R. Spence, Phytologia 89: 112. 2007.
Bryum gemmiparum De Not., Comment. Soc. Crittog. Ital. 2: 211. 1865.

Wyoming (FNA 28, 2014).

Imbribryum muehlenbeckii (P. Bruch & Schimp.) N. Pedersen, Bryologist 108: 449. 2005.
Bryum muehlenbeckii P. Bruch & Schimp., Bryol. Europ. 4: 163, plate 381. 1846.

Not reported for Wyoming by FNA (FNA Vol. 28, 2014). (As *Bryum muehlenbeckii*) Wyoming: Yellowstone Natl Park, sterile (*1513*) (Roell 1893).

Park Co.: SNF, Beartooth Plateau, SE shore of Island Lake, ecotone zone between willow wetlands and subalpine *Picea engelmannii* forest, on wet loamy soil, in shade, T57N R105W S3, 44°56.690–700' N, 109°32.230–240'W, 2900 m, 12 Aug 2008, *Kosovich-Anderson 2371* (ASC, COLO, DUKE) "det. by J. Spence" (see also Kosovich-Anderson & Weber 2011).



Courtesy FNA Association, FNA 28, 2014

ISOPTERYGIOPSIS Z. Iwatsuki, J. Hattori Bot. Lab. 33: 379, fig. 21. 1970. (Hypnaceae)

Isopterygiopsis pulchella (Hedw.) Z. Iwatsuki, J. Hattori Bot. Lab. 63: 450. 1987.
Leskea pulchella Hedw., Sp. Musc. Frond., 220, plate 55, figs. 7–12. 1801.
Holmgrenia diminutiva Grout
Hypnum nitidulum Wahlenberg
Isopterygium nitidulum (Wahlenb.) Kindb.
Isopterygium pulchellum (Hedw.) A. Jaeger
Isopterygium pulchellum var. *nitidulum* (Wahlenberg) Roth
Orthothecium diminutivum (Grout) H.A. Crum, Steere, & L.E. Anderson
Plagiothecium passaicense Aust.
Plagiothecium pseudolatebricolum Kindb.
Plagiothecium pulchellum (Hedw.) Schimp.

Wyoming (FNA Vol. 28, 2014). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: La Plata Mines, c.fr., 29 Aug 1898, *E. Nelson 5242* (RM), (orig. det. as *Plagiothecium Sullivantiae* Sch.—specimen autoicous, stem cortical cells thick walled).

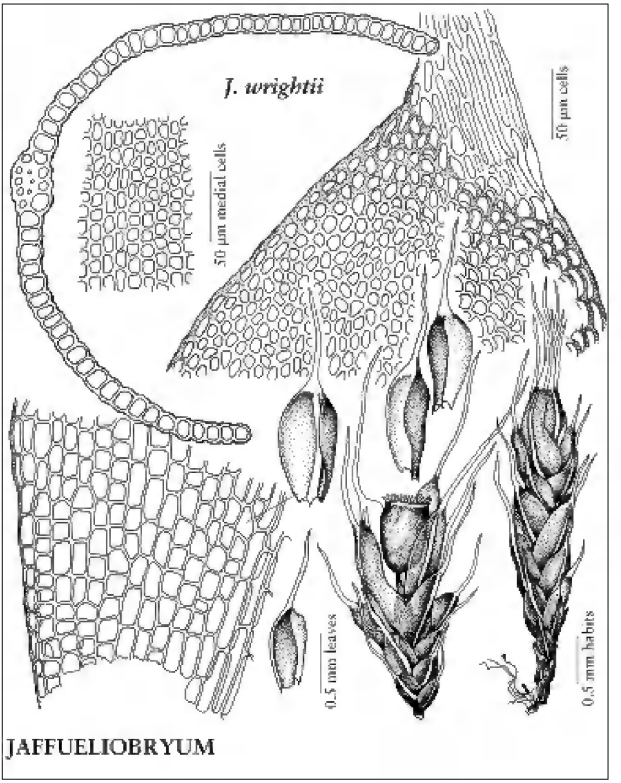
"Brooklyn Lake, Albany County (*Elias Nelson 5242*)" Porter (1935)—note that the label cited by Porter here does not bear the same data for Nelson 5242 as the specimen at RM. *Plagiothecium roseanum*, or *P. cavifolium* (Brid.) Iwats. is here excluded from Wyoming.

JAFFUELIOBRYUM Thériot, Rev. Bryol., n. s. 1: 192, plate 8, figs. 1–5. 1928. (Grimmiaceae)

Jaffueliobryum wrightii (Sull.) Thériot, Rev. Bryol., n. s. 1: 193. 1928.
Coscinodon wrightii Sull., Musc. Hepat. U.S., 132. 1856.
Grimmia wrightii (Sull.) Aust.

Laramie Co.: Pine Bluffs Rest Area on the I–80, Pine Bluffs, from holes in boulders sitting on rest area lawn, had been relocated from bluff, assoc. *Bouteloua gracilis* and other prairie ssp. (lawn grass), 22 Mar 1996, *Hoy 314,* young, calyptrate fruit, (BUF).

Lawton suggested that *Grimmia raui* Aust. (Bull. Torrey Club 6: 46. 1875) "is described as having the leaves entire, but specimens determined as *G. raui* commonly have some of the upper leaves minutely denticulate at the apex. it is questionable whether *G. raui* should be maintained as a distinct species" (Lawton 1971: 123). (As *G. raui* Aust) Carbon Co. "Rawlins, Jul 13, 1942, Degener & Peiler 16968" Wynne (1943). "Rare in the Pacific Northwest" Lawton.



Courtesy FNA Association, FNA 27, 2007

KINDBERGIA Ochyra, Lindb.ia 8: 53. 1982. (Brachytheciaceae)

Eurhynchium subg. *Stokesiella* Kindb., Eur. N. Amer. Bryin. 1: 93. 1897, not *Stokesiella* Lemmermann 1908 (Chrysophyta).

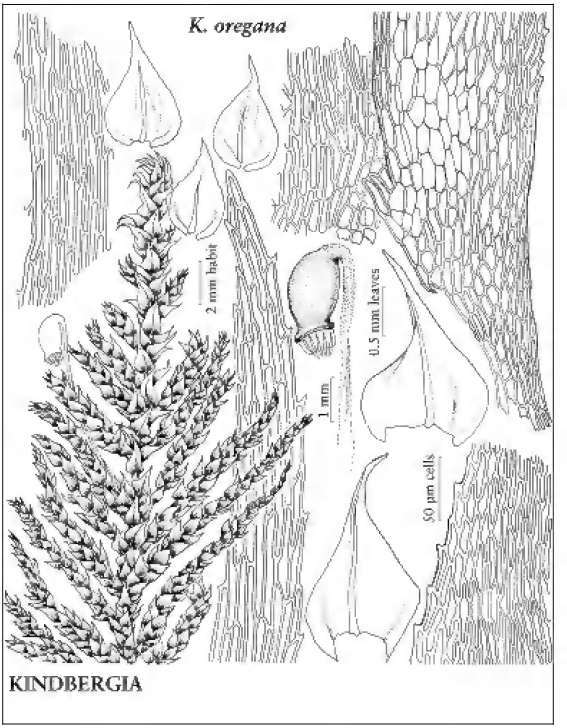
Kindbergia oregana (Sull.) Ochyra, Lindb.ia 8: 54. 1982.

Hypnum oreganum Sull., Mem. Amer. Acad. Arts, n. s. 4: 172. 1849.

Eurhynchium oreganum (Sull.) A. Jaeg.

Stokesiella oregana (Sull.) Robins.

Not reported for Wyoming in FNA (FNA Vol. 28, 2014). (As *Eurhynchium oreganum*) Teton Co., Spence (1985).



Courtesy FNA Association, FNA 28, 2014

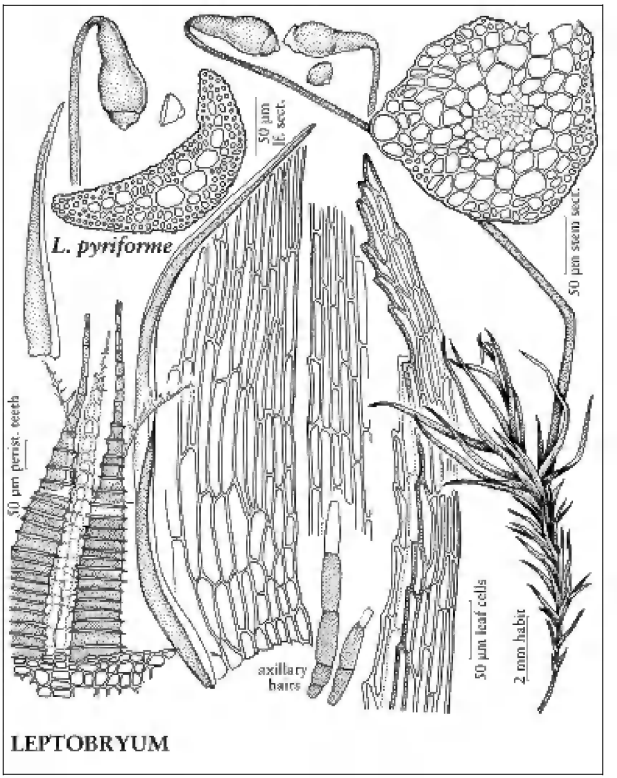
LEPTOBRYUM (Schimp.) Wilson, Bryol. Brit., 219. 1855. (Meesiaceae)
Bryum subg. *Leptobryum* Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 4: 1. 1851.

Leptobryum pyriforme (Hedw.) Wilson, Bryol. Brit., 219. 1855.
Webera pyriformis Hedw., Sp. Musc. Frond., 169. 1801.

Wyoming (FNA Vol. 28, 2014). Wyoming: Yellowstone Natl Park, c. fr., (*1520*) (Roell 1893). Cosmopolitan and common. "Common throughout most of the the State. Albany, Carbon, Fremont, (Sheridan), Sublette, Teton cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 7800 ft, *Hermann 25930* (RM); NW base of Sheep Mtn., seep area (calcareous fen) with *Populus, Betula,* and *Salix* dominant, 7 Jun 1993, *Buck 23223,* c. fr., young, some undeveloped (NY); La Plata Mines, 25 Aug 1898, *E. Nelson 5176,* in *Mnium marginatum* (packet), with *Bryum turbinatum* (RM). Bighorn Co.: Big Horn Mtns., on rotten logs, 8300 ft, 13 Jul 1979, *Nelson 3658* (RM). Carbon Co.: Haggarty Creek, Sierra Madre Mtns., 8440 ft, moist soil by creek, *Kastning-Culp 3032*, c.fr. (BUF). Fremont Co.: 8400 ft, *Hermann 25516* (RM). Johnson Co.: 6600 ft, *Nelson 6836b* (RM). Park Co.: 9500 ft, *Hermann 20069* (RM). Sweetwater Co: ca. 6400 ft, on US (187)191, at 14-Mile Reservoir picnic area, moist soils in shade above brooklet, with *Hennediella*

heimii, Campylium chrysophyllum, 5 Jul 1985, *Eckel 120186* (BUF, RH). Teton Co.: 7000 ft, *Hermann 25567* (RM). Yellowstone Natl Park, 8000 ft, *Hermann 20024* (RM); *Nelson 7804* (RM).

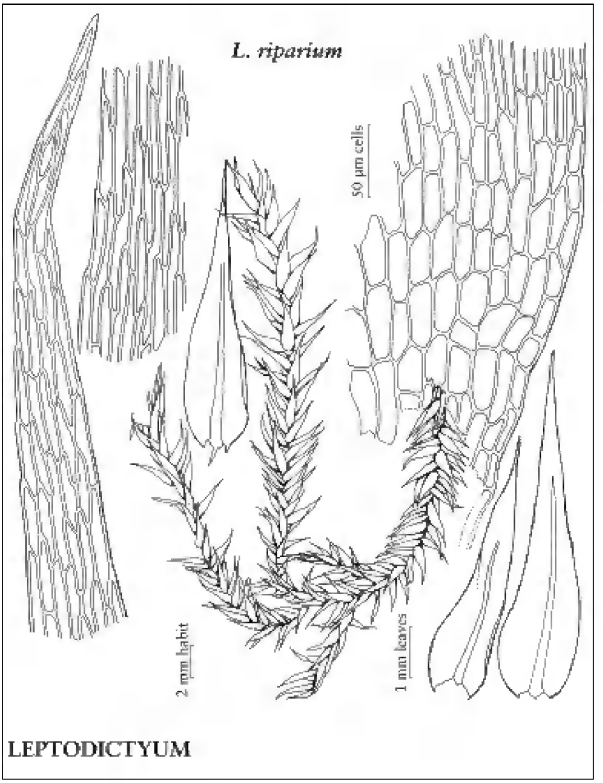


Courtesy FNA Association, FNA 28, 2014

Leptobryum pyriforme may be confused with another genus with long, setaceous leaves: *Distichium*, which has leaves coming off the stem alternately left and right, presenting a flattened face on the stem, whereas *Leptobryum* is whorled and the stem and leaves together are cylindrical overall. The capsules of *Distichium* are cylindric and erect to slighly inclined from the vertical, whereas *Leptobryum* has its distinct obpyriform (upside-down pear-shaped), highly glossy capsules.

LEPTODICTYUM (Schimp.) Warnst., Krypt.-Fl. Brandenburg 2: 867. 1906. (Amblystegiaceae)
Amblystegium subg. *Leptodictyum* Schimp., Syn. Musc. Eur., 595. 1860.

Leptodictyum humile (P.-Beauv.) Ochyra = Hygroamblystegium varium var. humile (P.-Beauv.) Vanderpoorten & Hedenäs



Courtesy FNA Association, FNA 28, 2014

Leptodictyum riparium (Hedw.) Warnst., Krypt.-Fl. Brandenburg, Laubm. 2(5): 878. 1906.

Hypnum riparium Hedw., Sp. Musc. Frond., 241. 1801.
Amblystegium brevipes Card. & Thériot
Amblystegium riparium fo. *fluitans* (Lesq. & James) Flow.
Amblystegium riparium var. *abbreviatum* Schimp. in B.S.G.
Amblystegium riparium var. *flaccidum* (Lesq. & James) Ren. & Card.
Amblystegium riparium var. *fluitans* (Lesq. & James) Ren. & Card.
Amblystegium riparium var. *longifolium* (Schultz) Schimp.
Brachythecium pennellii E.B. Bartram
Campylium polygamum var. *longinerve* (Ren. & Card.) Grout
Leptodictyum brevipes (Card. & Thériot) Broth.
Leptodictyum laxirete (Card. & Thériot) Broth.
Leptodictyum riparium var. *abbreviatum* (Schimp.) Grout
Leptodictyum riparium var. *brachyphyllum* (Card. & Thér.) Grout
Leptodictyum riparium var. *elongatum* (Schimp. in B.S.G.) Warnst.
Leptodictyum riparium var. *flaccidum* (Lesq. & James) Grout
Leptodictyum riparium var. *longifolium* (Schultz) Warnst.

Leptodictyum riparium var. *nigrescens* Wynne in E. Whiteh.
Leptodictyum riparium var. *obtusum* (Grout) Grout
Leptodictyum sipho (P.-Beauv.) Broth
Leptodictyum vacillans (Sull.) Broth.
Rhynchostegiella georgiana Dixon & Grout

Wyoming (FNA Vol. 28, 2014). (As *Leptodictyum riparium*) Albany Co., Yellowstone Natl Park, Porter (1937).

Albany Co.: NW base of Sheep Mtn. along WY 11, ca. 4 air mi ESE of Centennial, seep area (calcareous fen) with *Populus, Betula,* and *Salix*, *Buck 23235* (NY). Teton Co.: (var. *longifolium* (Schultz.) Mönk.) boggy area, 6700 ft, *Lichvar 704* (RM).

The overall delicacy of this species distinguishes it from species in the similar genus *Amblystegium*. The costa is thinner than the those in *Amblystegium*, except perhaps that of *A. serpens*, but this plant is usually bigger. In the Buck specimen, the plants have similar shape to *A. serpens* but are larger, larger cells, more delicate so more delicate in color (pale green). The apex was acuminate, the leaf broad at the base.

Lescuraea radicosa (Mitt.) Mönk. = Pseudoleskea radicosa (Mitt.) Mac. & Kindb.

Limprichtia revolvens (Sw.) Loeske = Scorpidium revolvens (Sw.) Rubers

Eckel, P.M. 2016. Annotated state and county checklist of the mosses of Wyoming, Part 1, M–Z. Phytoneuron 2016-18: 1–132. Published 3 March 2016. ISSN 2153 733X

ANNOTATED STATE AND COUNTY CHECKLIST OF THE MOSSES OF WYOMING, PART 2, M–Z

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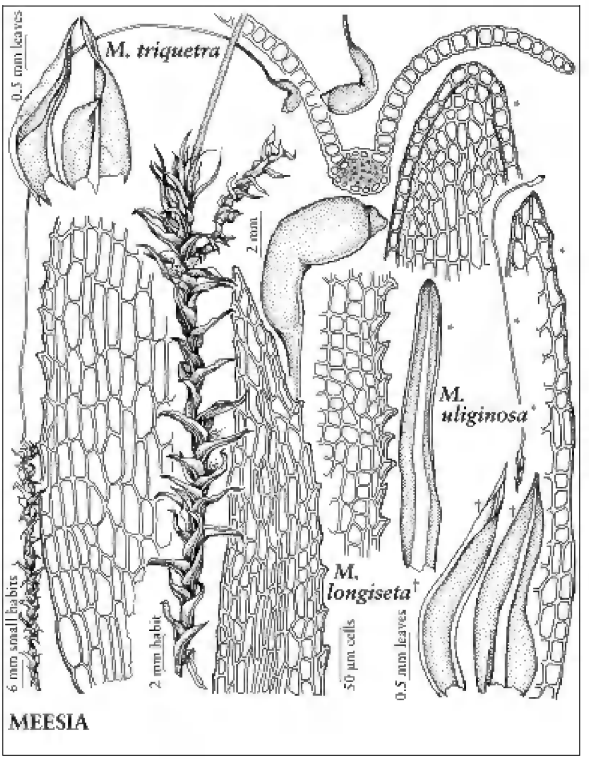
MEESIA Hedw., Sp. Musc. Frond., 173, plate 41, figs. 6–9. 1801, name conserved. (Meesiaceae)

Meesia longiseta Hedw., Sp. Musc. Frond., 173. 1801.

Johnson Co., in association with *Warnstorfia tundrae* (*Lenz 2006*). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



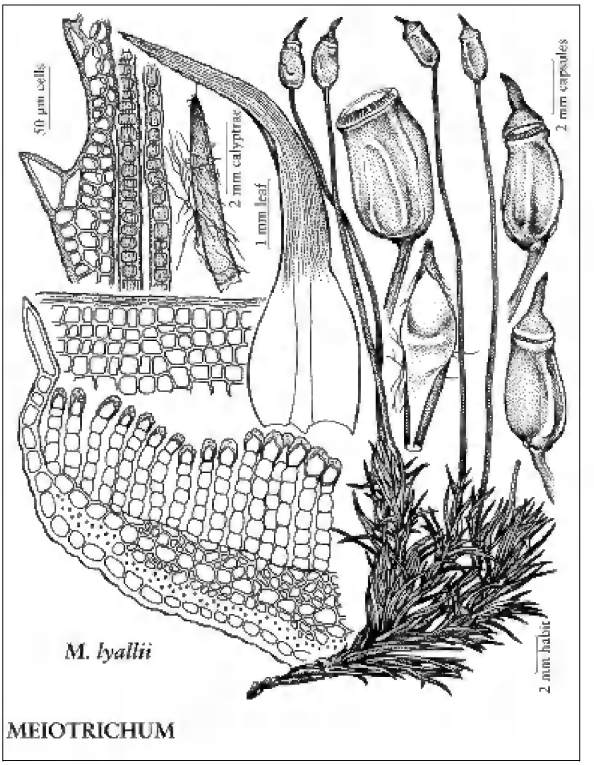
Courtesy FNA Association, FNA 28, 2014

[*Meesia triquetra* (Richt.) Angstr.) was reported for Johnson Co., Wyoming by Lenz (2006).

Meesia uliginosa Hedw., Sp. Musc. Frond., 173. 1801.
Meesia trichodes Spruce

Wyoming (FNA 28, 2014). (As *Meesia trichodes* Spruce) Boggy places near Fox Park, Albany Co. (*Nelson 9055*), Porter (1935). Johnson Co., in association with *Warnstorfia tundrae* (Lenz 2006). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Boggy places, Fox Park, Medicine Bow Mountains, *Nelson 9055* (RM).



Courtesy FNA Association, FNA 27, 2007

MEIOTRICHUM (G.L. Smith) G.L. Smith, Bryologist 95: 271. 1992. (Polytrichaceae)
Polytrichastrum sect. Meiotrichum G.L. Smith, Mem. New York Bot. Gard. 21(3): 40. 1971.

Meiotrichum lyallii (Mitt.) G.L. Smith, Bryologist 95: 271. 1992.
Polytrichadelphus lyallii Mitt., J. Linn. Soc., Bot. 8: 49, plate 8. 1864.
Oligotrichum lyallii (Mitt.) Lindb.
Polytrichastrum lyallii (Mitt.) G.L. Smith
Polytrichum angustidens H. Lindb.
Polytrichum lyallii (Mitt.) Kindb.

Wyoming (FNA, Vol. 27, 2007). (As *Polytrichastrum lyallii* Teton Co., Spence 1985). ...throughout the Pacific Northwest; Yukon, California, Nevada, Utah, Colorado, Arizona, New Mexico. Albany, Carbon cos., Yellowstone Natl. Pk., Porter (1937). (As *Polytrichum lyallii*) "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, Spence (1981). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Polytrichum lyallii*: all) Carbon Co.: Medicine Bow Range, *Porter 9699* (RM); Sierra Madre Range, 9600–10,000 ft, wet area by bog, *Kastning-Culp 700* (BUF, RM). Fremont Co.: on US26 & US287, 5 mi E of Togwotee Pass, S slope, Bridger-Teton Natl. Forest, ca. 9000 ft, open Pine-Spruce woods, xeric, in duff on slope, some *Artemisia tridentate,* 6 Jul 1985, *Eckel 94082002,* c.fr. (BUF, RM). Park Co.: 2900 m, *Weber B–44239* (COLO, RM). Sheridan Co.: 7800 ft, limestone area, *Dueholm 8248* (RH).

MNIUM Hedw., Sp. Musc. Frond. 188, plate 45. 1801, name conserved. (Mniaceae)

Mnium affine: see Plagiomnium affine.

Mnium ambiguum H. Müll. = Mnium lycopodioides Schwägr.

Mnium arizonicum J.J. Amann, Rev. Bryol. 52: 23. 1925.

Wyoming (FNA, Vol. 28, 2014). B.C. Wyoming; Ariz, Nev., Utah, Colo. Wyoming, Flowers (1973). Wyoming: Teton Co.: Cascade Canyon 1953, Conard (CANM), Koponen (1972). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 8000 ft, *Hermann 17114* (RM); 10,800 ft, *Rolston 86085* (CSU); 8000 ft, *Eckel 120886* (BUF, RM). Park Co.: thin soil over dry, shaded rock under open canopy of Douglas fir, at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1784* (BUF); 8300 feet, *Elliott 13110* (RM, BUF). Park Co.: T 54 N, R 105 W, Sec. 13 N, 8000 ft, *Nelson 13151* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1/2 mi SW of Barnes Lake, 9760 ft, 42°57'N, 109°36'W, terrace fen, on N facing rock at edge of fen, 15 May 1989, *Andrus 7826* (BING).

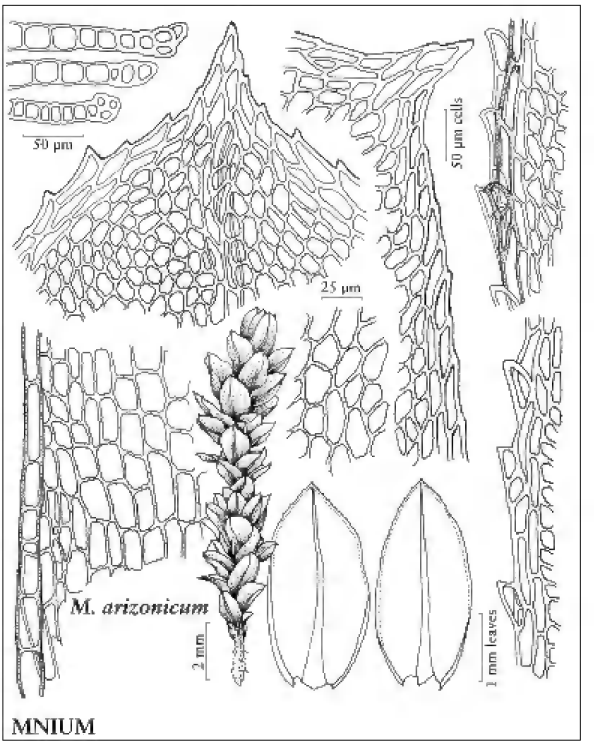
"This is the only *Mnium* with pitted cell walls" (McIntosh & Newmaster, FNA Vol. 28, 2014); it has no plagiotropic stems in sterile shoots (unlike *Plagiomnium* spp.); the bright green laminae contrast with the red stems, little tomentum, leaves strongly twisted around the stems. Unlike *Plagiomnium ellipticumm*, (with plagiotropic stems) the leaves are obovate and acute (not nearly orbicular) and the marginal cells are short-rhombic near the apex (not long-linear). The laminal cells of *M. arizonicum* are diagonal out from the costa, then tend to become parallel to the margin along the margin in several rows. The cells are porose, rather thick, especially distally, and are not collenchymatous.

Mnium bimum Schreber = Ptychostomum bimum (Schreber) J.R. Spence

Mnium blyttii P. Bruch & W.P. Schimper, Bryol. Europ. 4: 208, plate 400. 1846.
Astrophyllum blyttii (B.S.G.) Lindb.

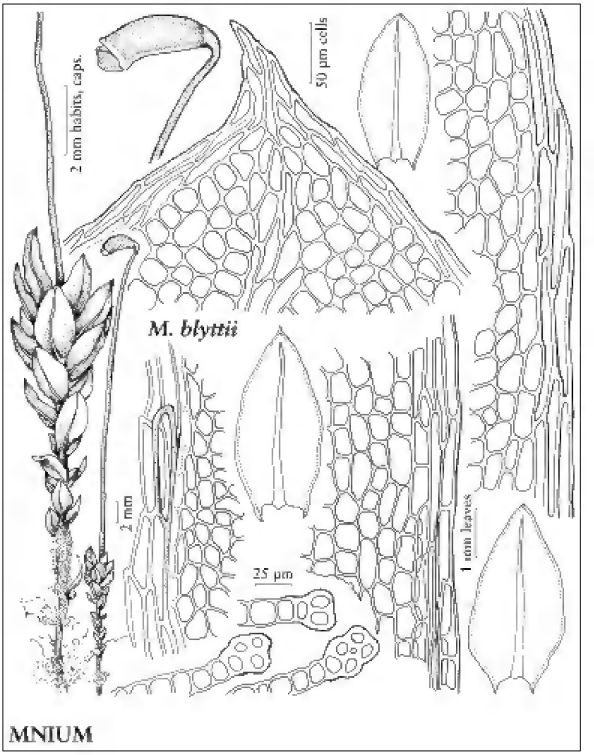
Wyoming (FNA, Vol. 28, 2014). B.C., Northw. Terr., Yukon; Alaska, Wash., Idaho, Mont., Colo., Utah, Wyoming; Greenland. Togwotee Pass, Fremont Co., Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 8500 ft, *Lichvar 1341* (RM); 10,000 ft, *Hermann 17699* (RM). Fremont Co.: 8400 ft, *Hermann 25512* (RM). Sheridan Co.: 6600–8000 ft, *Odasz 1127* (BUF, RM). Sublette Co.: 7950 ft, *Hermann 25329* (RM).



Courtesy FNA Association, FNA 28, 2014

After *Mnium arizonicum* with its porose cell walls, the taxon *M. blyttii* might be most easily confused with is *M. thomsonii*. The last has elongate leaves, vs. the short, broad at the middle leaves of *M. blyttii*. The latter also has consistent sharp, clear double teeth on the margins, whereas *M. byttii's* are variable, generally blunter. Variation is conspicuous in *blyttii*, its leaf cells sometimes as small as those of *M. thomsonii*, sometimes as large as in the descriptions, and *M. blyttii* does have rounded corners, slightly, not angular (for *M. thomsonii,* Crum & Anderson 1981 say "more or less thickened at the corners Vol.1, p. 587"). In *M. blyttii* the margins are variously single layered to many: nearly three. My impression of *M. thomsonii* is that it is more stable in its characteristics. The leaf shape seems to be the best character to differentiate them (*M. blyttii* is broadest at the middle, also densely rhizoidal, whereas *M. thomsonii* is scarcely so—Lawton 1971). Also *M. thomsonii* seems to have some teeth at the back of the costa, which was hard to demonstrate in any of the, e.g., McKee specimens. Use the complexity of the leaf margin to separate from *M. marginatum* (q.v.) in sterile specimens. "Doubtful specimens are easily distinguished by the following chemical test: heat a leaf with alcohol to destroy the chlorophyll, then add a drop of KOH. The leaf should turn blue-green" Weber (1973: 24).



Courtesy FNA Association, FNA 28, 2014

Mnium hornum Hedw., Sp. Musc. Frond. 188. 1801.

Not reported for Wyoming by FNA (FNA, Vol. 28, 2014). Brooklyn Lake, Albany Co. (*Nelson 5171*), Porter (1935).

"Mnium hornum is one of the most distinctive members of the genus. The long, narrow leaves and strongly toothed abaxial costae are diagnostic for the species, as is the presence of small, narrowly triangular, mostly smooth-margined leaves on the proximal portions of the stem" (McIntosh & Newmaster, FNA 28, 2014). This mostly eastern species does occur in Colorado, though rarely, being a "Pleistocene relict species of the eastern American woodlands" (Weber & Whittmann (2007).

Mnium lycopodioides Schwägr., Sp. Musc. Frond. Suppl. 2(2,1): 24, plate 160 (bottom). 1826.
Mnium ambiguum H. Müller
Mnium lycopodioides var. *inclinatum* (Lindb.) Wijk & Marg.
Mnium pseudolycopodioides Müll. Hall. & Kindb. in Macoun
Mnium umbratile Mitt.

Wyoming (FNA, Vol. 28, 2014). (As *Mnium ambiguum*) B.C., Wash, Oregon, Idaho, Mont., Wyoming; Col; Ontario, New Eng., New York.

(As *Mnium ambiguum*) Albany Co.: 8590 ft, *Hermann 24878* (RM); 10,000 ft, *Hermann 17703* (RM).

Mnium marginatum (Dickson ex Withering) P.-Beauvois, Prodr. Aethéogam., 75. 1805.
Bryum marginatum Dickson ex Withering, Syst. Arr. Brit. Pl. ed. 4, 3: 824. 1801.
Mnium serratum Brid.

Wyoming (FNA, Vol. 28, 2014). B.C., Wash., Alberta, Idaho, Mont., Wyoming; Calif., Ariz., Col; South Dak., Iowa, Missouri, Ark., Ontar; Quebec, New Engl., N. Car. (As *Mnium serratum*) Wyoming: Yellowstone Natl Park, c.fr., (1522) (Roell 1893). (As *Mnium serratum* Schrad.) Albany Co., "from several locations," Porter (1935). (As *Mnium subglobosum* B. & S.) Albany Co. (*Nelson 1744 & 2702*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: in deep shade on wet, peaty, wooded bank of Nash Fork on Sand Lake Rd., 2 mi NW of Rte 130, alt. 8500 ft, Medicine Bow Mts., ca. 4 mi 2 of Centennial, 5 Aug 1962 *Hermann 17778*, sterile specimen seen, with complex marginal cell bundle (RM); La Plata Mines, 25 Aug 1898, *Nelson 5176* c.fr., with *Leucobryum pyriforme, Bryum turbinatum, Distichium capillaceum* (RM). Park Co.: T55N, R104W Sec. 25, 26, 6800–7400 ft, *Hartman 22062* (RM) . Sublette Co.: wet, peaty knoll under spruce on W shore of Lower Green River Lake, alt. 7950 ft, Wind River Range, 50 mi N of Pinedale, 19 Jun 1973, *Hermann 25330* (RM). Teton Co.: on US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, *Lupinulus*, Asters, wooded stream, soggy debris, 6 Jul 1985, *Eckel 94082106,* c.fr., with *Brachythecium salebrosum, Distichium capillaceum, Aulacomnium palustre, Cratoneuron filicinum* (BUF)

Distinctive for *M. marginatum* are the double teeth (*Mnium*), synoicous inflorescences (good distinction from *M. blyttii*) and thickened cell corners. Especially in sterile specimens, the teeth are sometimes very low and blun,t and the doubleness is not demonstrable (as noted by Flowers 197i3). Distinguishing *M. marginatum* it from *M. blyttii* is through the complexity of the marginal cell bundle (cf. Lawton's 1971 key: if only two or three cells the plant might be *M. blyttii*. If four or more, it is *M. marginatum*. Otherwise the areolation of both species are the same as described. To differentiate from *M. lycopodioides*, as in Lawton's key, that species has well-defined teeth.

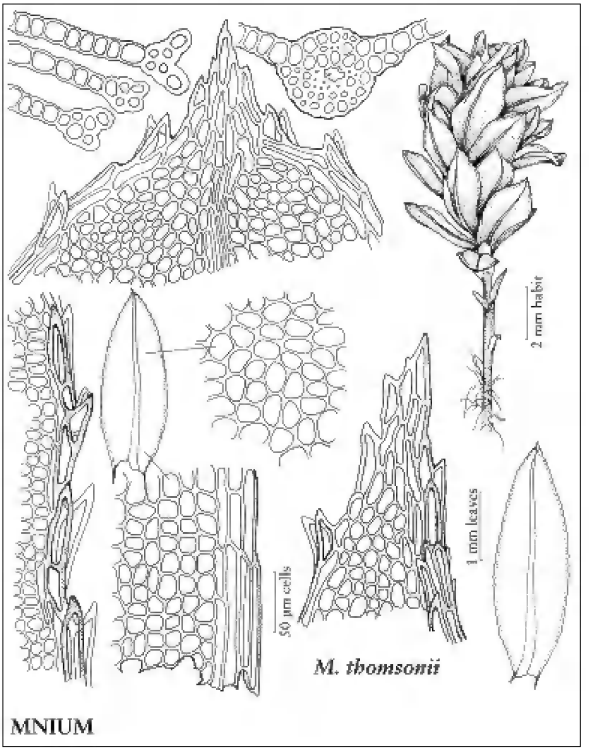
Mnium orthorhynchium sensu auct. plur. = M. thomsonii Schimp. (From the Anderson et al. 1990 checklist, another misuse of *M. orthorhynchium*. is for *Atrichum tenellum* (Roel.) P. Bruch & Schimp. in B.S.G. which has not been reported for Wyoming, FNA Vol. 27, 2007.)

Mnium spinulosum P. Bruch & W.P. Schimper, Bryol. Europ. 4: 206, plate 394. 1846.

Not noted for Wyoming in FNA (FNA, Vol. 28, 2014). Battle Creek Canyon, Carbon County (*Porter 1720*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

"*Mnium spinulosum* is distinguished by broad, thick, and pigmented leaf margins, usually obovate leaves, and dark red-brown exostomes" (McIntosh & Newmaster, FNA Vol. 28, 2014).

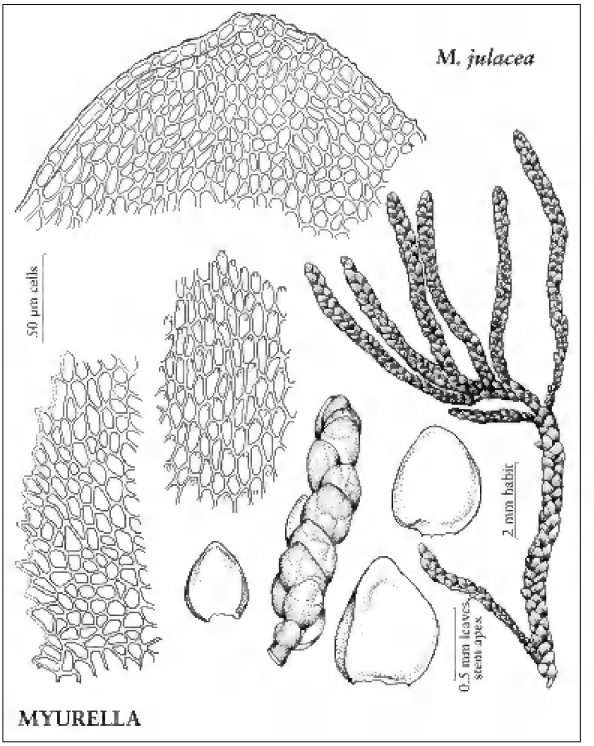
Mnium thomsonii Schimp., Syn. Musc. Eur. ed. 2, 485. 1876 (as thomsoni)
Astrophyllum orthorrhynchum (Brid.) Lindb.
Mnium decurrens Müll. Hall. & Kindb. in Macoun
Mnium inclinatum Lindb.
Mnium lycopodioides ssp. *orthorrhynchum* (Lindb.) Wijk & Marg.
Mnium orthorhynchum Brid.



Courtesy FNA Association, FNA 28, 2014

Wyoming; "the small laminal cells, the smallest in the genus, are diagnostic" (McIntosh & Newmaster, FNA, Vol. 28, 2014). B.C., Wash., Oregon, Alberta, Mont., Wyoming; Colo., Minnesota, Ont., Iowa, Ark.; Greenland, Quebec, Nova Scot, N.C. (As *Mnium orthorhynchum*) Albany, Sublette cos., Porter (1937). Teton Co., Spence (1985). "Both of these specimens are sterile. *692* was determined by Dr. Grout as being almost certainly this species," Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: soil on wet rocky edge of stream in aspens, alt. 8590 ft, NW slope of Pole Mt., Poly creek Campground, Medicine Bow N.F., 9 mi SE of Laramie, Centennial, 7 Jun 1972, *Hermann 24868* (RM); Medicine Bow Mts., Libby Creek, growing along rotten log on moist soil, common (in packet of *Brachythecium erythrorrhizon*), *Lichvar 1347b* (RM). (As *Mnium orthorrhynchum)* Albany Co.: 10,000 ft, *Hermann 17728* (RM). Park Co.: 6500 ft, *Hermann 20036* (RM); 7500 ft, *Hermann 20056* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, with *Bartramia ithyphylla,* 14 May 1989, *Andrus 7787a* (BING).



Courtesy FNA Association, FNA 28, 2014

The Albany Co. specimen of Hermann (*24868*) had non-varying double teeth, smaller leaf cells, long thin leaves, thick walls with minor corner thickenings and dioicous. The specimen was determined by T. Koponen as *M. marginatum*, but perhaps in distribution duplicate specimens got mixed.

Mnium orthorhynchum Brid. = Mnium thomsonii Schimp.

MYURELLA Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 39, plate 560. 1853. (Pterigynandraceae)

Myurella julacea (Schwägr.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 41. 1853.
Leskea julacea Schwägr. in J.A. Schultes, Reise Glockner 2: 363. 1804.

Wyoming; "Plants of *Myurella julacea* are distinguished by their small, wormlike habit and yellow-green color" (Vitt, FNA Vol. 28, 2014).

Albany Co.: Hermann 17222 1/2 (RM): fragmentary but distinctive material.

NECKERA Hedw., Sp. Musc. Frond., 200, plate 46, figs. 10–15; plates 47, 48. 1801, name conserved. (Neckeraceae) ·

Neckera pennata Hedw., Sp. Musc. Frond., 200. 1801.
Neckera oligocarpa Bruch
Neckera pennata var. *oligocarpa* (Bruch in Ángstr.) Müll. Hall.
Neckera pennata var. *tenera* Müll. Hall.

Not noted for Wyoming by FNA, but within the range of the species (FNA, Vol. 28, 2014). Lawton (1971), indicated a specimen from Wyoming. (As var. *oligocarpa* B. & S.) Hawk's Ranch, Colorado-Wyoming State line, Albany County (Nelson 11,297), Porter (1935). (As var. *oligocarpa* (Bruch) Grout), Albany Co., Porter (1937).

Albany Co.: *Porter 1754* (RM).

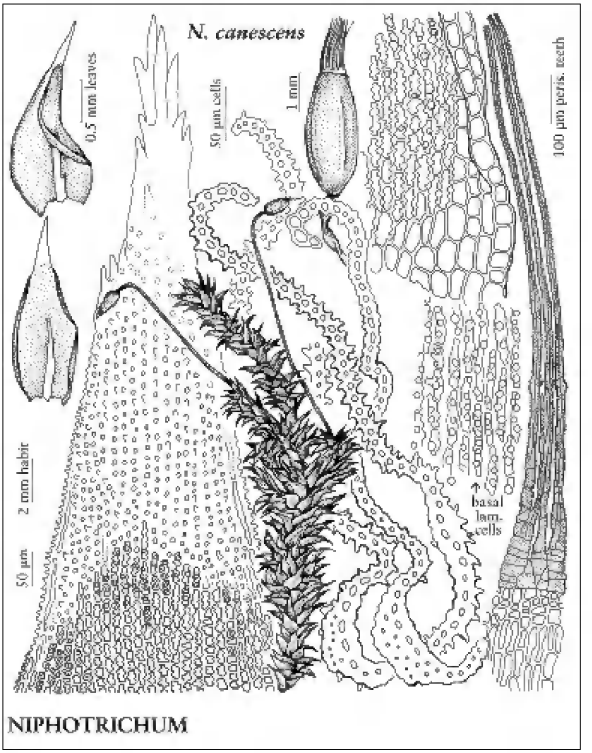
NIPHOTRICHUM (Bednarek-Ochyra) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 137. 2003. (Grimmiaceae)
Racomitrium subg. *Niphotrichum* Bednarek-Ochyra, Fragm. Florist. Geobot., Ser. Polon. 2: 70. 1995.

Niphotrichum canescens (Hedw.) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 137. 2003.
Trichostomum canescens Hedw., Sp. Musc. Frond., 111. 1801.
Bryum canescens (Hedw.) Wither.
Grimmia canescens (Hedw.) Muller Hal.
Racomitrium canescens (Hedw.) Brid.
Racomitrium canescens fo. *ericoides* (Hedw.) Mönk
Racomitrium ericoides (Hedw.) Brid.
Trichostomum ericoides Hedw.

Only the subsp. *canescens* is reported for Wyoming in FNA (FNA, Vol. 27, 2007). (As *Racomitrium canescens*) In all states and provinces of the Pacific Northwest; Alaska, Cal., Colo.; Michigan, Ontario; Greenland, New England. (As *Rhacomitrium canescens*) Sundance, Crook County (Nelson 9704); Leigh Lake, Teton County (Porter 1192); around hot springs, Nez Perces Creek, Yellowstone Natl Park (*Nelson 6210*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Racomitrium canescens*) Park Co.: 2900 m, *Weber, B–44286* (RM, COLO). Sublette Co.: (conforms to Lawton's var. *ericoides*) as ssp. *canescens* (Frisvoll), 11,200 ft, *Rolston s.n.* (CSU). Teton Co.: gravelly soil, dry stream bed, entrance to Leigh Lake, 7,000 ft, 2 Aug 1932, *Porter 1192* (WTU); Teton Natl. Park, Cascade Trail, 14 Aug 1953, *Lawton, 1764* (WTU). Yellowstone Natl Park, *Nelson & Nelson 6210* (RM); In woods near Old Faithful Geyser, 15 Aug 1925, *Frye s.n.* (WTU); near Roaring Mountain, 16 Aug 1925, *Frye s.n.* (WTU); 1 mi N of Thumb, on dry rocky soil, 7 Jul 1934, *Frye s.n.* (WTU); Norris Geyser Basin, wet soil,14 Aug 1925, *Frye s.n.* (WTU); about 5 mi from Canyon Lodge road to Norris, 29 Aug 1951, *Lawton 1500* (WTU); on boulder along Firehole River near Old Faithful, 6 Jul 1934, *Frye s.n.* (WTU); about Terrace Hotspring, 20 Jun 1931, *Frye s.n.* (WTU); in open dry place, sandy soil at W Thumb, 1 Aug 1932, *Smiy 126* (WTU).

(As *Racomitrium canescens*) since I have not made a study of American plants of *Racomitrium canescens* (Timm ex Hedw.) Brid. as to their distinction from *R. ericoides* (Web) ex Brid.) Brid. or *R. elongatum*, as per Frisvoll 1983, I have chosen to follow Lawton (1971) and the conservative concepts of Crum and Anderson (1981), which lump these species under *R. canescens* (Hedw.) Brid. There is a var. *latifolium* C. Jens. in the Anderson et al. (1990) checklist.



Courtesy FNA Association, FNA 27, 2007

Niphotrichum elongatum (Frisvoll) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003.
Racomitrium elongatum Frisvoll, Gunneria 41: 74, figs. 1983.

Wyoming (FNA, Vol. 27, 2007).

Niphotrichum ericoides (Brid.) Bednarek-Ochyra & Ochyra in R. Ochyra et al., Cens. Cat. Polish Mosses, 138. 2003.
Trichostomum ericoides Brid., J. Bot. (Schrader) 1800(2): 290. 1801).
Bryum ericoides (Brid.) Dicks.
Grimmia canescens (Hedw.) Müll. Hal. var. *ericoides* (Brid.) Müll. Hal.
Racomitrium brevipes Kindb. var. *ericoides* (Brid.) Kindb.
Racomitrium canescens var. *ericoides* (Brid.) Hampe
Racomitrium ericoides (Brid.) Brid.
Trichostomum canescens Hedw. (unranked) *ericoides* (Brid.) Hartm.

Wyoming (FNA, Vol. 27, 2007).

ONCOPHORUS (Brid.) Brid., Bryol. Univ. 1: 389. 1826. (Dicranaceae)
Dicranum sect. Oncophorus Brid., Muscol. Recent., suppl. 4: 53. 1819.

Oncophorus virens (Hedw.) Brid., Bryol. Univ. 1: 399. 1826.
Dicranum virens Hedw., Sp. Musc. Frond., 142. 1801.
Cynodontium virens (Hedw.) Schimp.
Dicranum virens var. *serratum* B.S.G.
Oncophorus virens var. *serratus* (B.S.G.) Braithw.

Wyoming (FNA, Vol. 27, 2007). Throughout the Pacific Northwest; Alaska, California, Colorado, Utah, Nevada, New Mexico; Minnesota, Michigan; Greenland, Nova Scotia, Quebec. Fairly common along streams from 9,000–10,000 ft,in southeastern Wyoming; Albany (Porter 1372), (Carbon, Johnson cos.) Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: peaty vertical bank of streamlet in mountain meadow, 1 1/4 mi S of Brooklyn Lake, 10,000 ft, Medicine Bow Mts., 9 mi W of Centennial, 2 Aug 1962, *Hermann 17679,* c.fr. (RM). Carbon Co.: moss-covered, peaty bank of Trail Creek, W of Sand Lake Rd., 9000 ft, Medicine Bow Mts., 4.5 mi SW of Morgan, 6 Aug 1962, *Hermann 17798,* c.fr. (RM). Fremont Co.: 12,500 ft, wet places near small waterfall, 6 Aug 1963, *Jozwik 471,* c.fr., (RM). Park Co.: alpine bog, 3250 m, *Weber, B–44223* (RM, COLO); Beartooth Plateau, Cooke City to Red Lodge Highway, alpine bog of E summit, E slope, head of Wyoming Creek, 3250 m, *Weber, B- 44264* (COLO, RM).

Oncophorus wahlenbergii Brid., Bryol. Univ. 1: 400. 1826.
Oncophorus wahlenbergii var. *compactus* (P. Bruch & W.P. Schimper) Braithwaite

Wyoming (FNA, Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: 2900 m, c.fr., Aug 19 1973, *Weber B–44288* (RM, COLO). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May 1989, *Andrus 7784a,* with *Campylium stellatum*, *Climacium americanum* & *Distichium capillaceum* (BING).

The Andrus specimen had a single stem with many flagellate branches with minute distant leaves in the apex! The costa has a tendency to come off the stem in a long strip in this species with decurrent leaves—both characters similar to those of *Bryum pseudotriquetrum*.

ORTHOTRICHUM Hedw., Sp. Musc. Frond., 162. 1801. (Orthotrichaceae)

Orthotrichum affine Schrader ex Brid., Muscol. Recent. 2(2): 22. 1801.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014). Albany County (Porter 1004), (Washakie Co.), Porter (1935).

Orthotrichum alpestre Hornschuch ex P. Bruch & W.P. Schimper, Bryol. Europ. 3: 75, plate 213. 1849.
Orthotrichum alpestre var. *majus* Lesq. & James
Orthotrichum alpestre var. *watsonii* (James) Grout
Orthotrichum occidentale James
Orthotrichum watsonii James

Wyoming (FNA, Vol. 28, 2014). Albany Co. (*Porter 1288*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: exposed crevices in granite boulder on grassland, Laramie Mts., Horse Creek drainage, 8000 ft, 10 mi ENE of Laramie, 17 Aug 1961*Hermann 17112* (RM); Laramie Mountains, Roger Canyon, 8 air mi NE of Laramie city center; 7850–8000 ft, thin soil over limestone boulder, 7 Jun 1993, *Miller 10,240* c.fr. (NYS). Bighorn Co.: UTM 13 316537 E 4900238 N, on rock in forest; on forested, rocky north slope of weathered limestone, with *Picea engelmannii*; near Soldier Creek Cow Camp, ca. 4.5 air mi WSW of W Tensleep Lake, Bighorn Natl Forest, 8285 ft (2526 m), 28 Aug 2005, *Lenz no 2261* (MO). Johnson Co.: UTM 13 342387 E 4902965 N, on rock under overhand, large rock outcrop with *Populus tremuloides* on N side and *Pinus contorta* around S side, ca. 6.6 air mi E of Bighorn Peak; Bighorn Natl Forest, 8180 ft (2494 m), 29 Aug 2005, *Lenz 2367* (RM). Park Co.: 7500 ft, Hermann 20062 (RM). Fremont Co.: rock outcrop along stream, Fiddler's Lake Rd (Wyo. 131), 8600 ft, 14 mi SSW of Lander, 18 Jun 1973 *Hermann 25310* (RM). Yellowstone Natl Park: 5500 ft, *Hermann 20014* (RM).

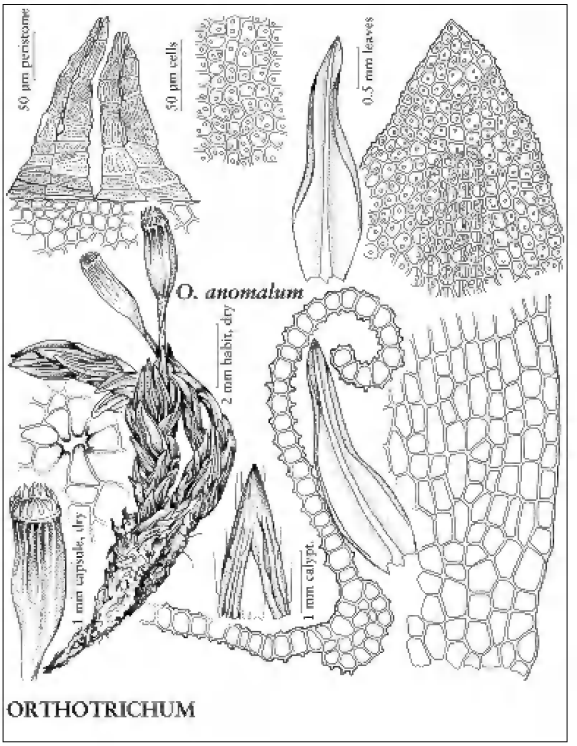
A specimen of this species was noted to have a bright blue-green or verdigris-like color of the stems, and bright red-brown tomentum, as mentioned by Crum and Anderson (1981) citing Hinneri (Ann. Univ. Turku A, II, 58:1–37 1976), who reported a "bluish color of the tufts and a rich, red-brown tomentum." The loose leaves when dry and bright color are suggestive of other mosses, such as *Hymenostylium recurvirostrum*.

The capsule cell walls are thin in the furrows and thicker in the ribs. Basal cells thin-walled and even, as is typical of *Orthotrichum* species with immersed capsules. In section, the cross-walls are thin, the outer surface thick, with tall simple or widely- forked papillae. The emergent capsules are strongly 8-ribbed and strangulate or constricted when dry. Peristome teeth are 8, together with 16 robust endostome teeth that may be erect, wide-spreading or typically strongly deflexed and lying along the capsule mouth. In the latter case, the distinctive endostome segments appear as erect filaments. Axillary perigonia occur in the leaf axils below the perichaetia (not at the ends of separate branches, as in *O. pallens*, which also has 16 endostome segments and a naked calyptra). The rather sparsely hairy calyptra hairs are papillose.

Orthotrichum anomalum Hedw., Sp. Musc. Frond., 162. 1801.
Orthotrichum anomalum var. *americanum* Macoun & Kindb.
Orthotrichum canadense P. Bruch & W.P. Schimper
Orthotrichum consimi subsp. *anomaloides* Kindb.

Wyoming; "The most useful character in distinguishing plants of this species is the exserted capsule with eight long ribs alternating with eight shorter ones" (Vitt, FNA Vol. 28, 2014). Albany Co. (*Porter 756*), Porter (1935).

Albany Co.: On granite rocks, Hawk's Ranch, 26 Apr 1931, *Porter 756*, c.fr., (NY). Weston Co.: Newcastle, on arid rock in dryish canyon, 16 Jul 1942, *Leroy Peiler 17,030* (NY).



Courtesy FNA Association, FNA 28, 2014

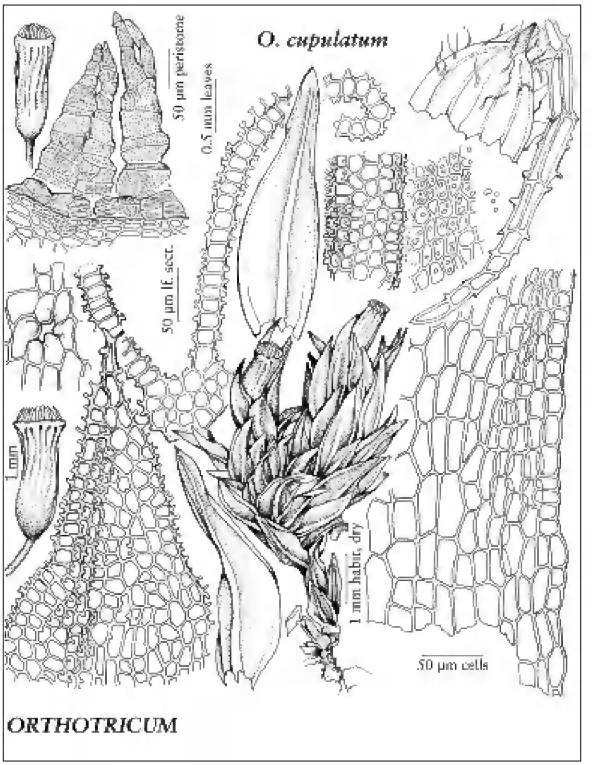
Orthotrichum cupulatum Hoffmann ex Brid., Muscol. Recent. 2(2): 25. 1801.
Orthotrichum leiodon Kindb.
Orthotrichum utahense Lesq.

Wyoming (FNA, Vol. 28, 2014). Apparently the commonest species. Albany, Teton cos., Porter (1937). Teton Co., Spence (1985), citing Porter. Albany Co., Telephone Canyon, *Porter 606, 685, 1270* (TENN), Vitt (1973).

Albany Co.: Laramie Mts., Roger Canyon, ca. 8 air mi NE of Laramie, 2400 m, limestone outcrops with *Cercocarpus montanus*, 7 Jun 1993, *Buck, 23151* (NY), capsules with calyptrae. Fremont Co.: 9300 ft, *Hermann 25300* (RM). Sheridan Co.: T 56N, R 87W S14 Big Horn Mts.; ca 4 air mi SSW of Dayton, forested valley trhough Chugwater redbeds and limestone outcrops and forest margin, 4800 ft, Aug 3 1979, *Hartman 10648* (RM).

The leaf lamina has an occasional bistratose patch or streak especially in the apical part. This feature is not rare, but is not evident in many cross sections even on the same leaf—certainly not as evidently bistratose as *O. pellucidum*, which was once considered to be a variety of this species. The 16 ribs in the dry capsule are conspicuous and the capsules are more immersed than emergent—in *O. pellucidum* the capsules are emergent to shortly exserted—in some collections most of the stems have

shortly exserted capsules (a bit of the seta can be seen below the base of the capsule). The leaf lamina is continuously bistratose throughout in *O. hallii*.



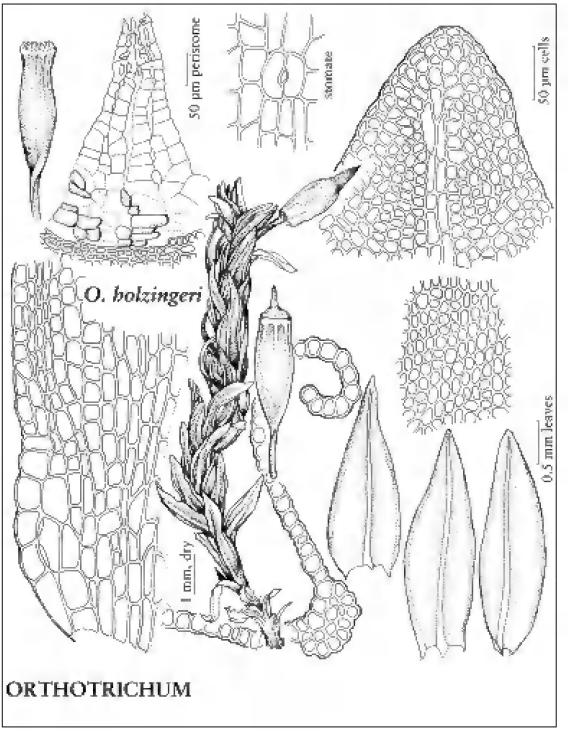
Courtesy FNA Association, FNA 28, 2014

Orthotrichum jamesianum Sull. in James in Watson = Orthotrichum pellucidum Lindb.

Orthotrichum hallii Sull. & Lesq. in W.S. Sull., Icon. Musc., suppl., 63, plate 45. 1874.

Wyoming (FNA, Vol. 28, 2014). Albany County (Porter 485 & 638), (Natrona Co.), Porter (1935). Wyoming, Flowers (1973). Campbell Co., Medina (1994).

Albany Co.: *Eckel 871104* (RM, BUF); 8600 ft, on granite rocks, 7 Apr 1988 *Vukelich s.n.* (BUF); along Roger Canyon in the Laramie Mtns, 7 mi due NE of Laramie city center, *Artemisia* scrub vegetation; limestone cliffs and outcrops, 7600 ft, vertical seeping crack in limestone cliff, 7 Jun 1993 *Reese 18158,* with *Grimmia anodon* (LAF). Fremont Co.: 9300 ft, *Hermann 25298* (RM). Park Co.: T55N R104W, sec 5,6,7 5600–6000 ft, *Hartman 20603 a & b,* with *O. rupestre* and *O. laevigatum* (RM).



Courtesy FNA Association, FNA 28, 2014

The lamina is essentially completely or continuously 2(–3)-stratose, whereas in *O. cupulatum* it is only interruptedly bistratose in streaks, or, in *O. pellucidum*, the streaks are broader but never continuous. The stomata of the capsule are immersed, the basal cells thin and even-walled. The capsules are emersed with only 8 (not 16) ribs. The most distinctive feature of this moss is the essentially completely bistratose laminae in the distal leaf and the papillae that are low and obscure (not high and forked). The peristome teeth may be striate with ridges or with small, conic papillae. They may be proximally coarsely papillose and distally with striae and papillae mixed (after Vitt, FNA Vol. 28, 2014). *Orthotrichum alpestre, O. pallens and O. pumilum* are all unistratose, the last two with stems less than 0.5 mm long (*O. hallii* is 1–1.5 cm high).

Orthotrichum holzingeri Renault & Card., Contr. U.S. Natl. Herb. 3: 270. 1895.

Wyoming (FNA, Vol. 28, 2014). "Fremont Co.: Shoshone Natl Forest, Wind River Mountains, along Hwy 131, SW of Lander, between Sinks Canyon St. Pk. and Frye Lake, 10.0 km NE of Frye Lake, 2,200 m, *Vitt 35377*, Vitt (1991).

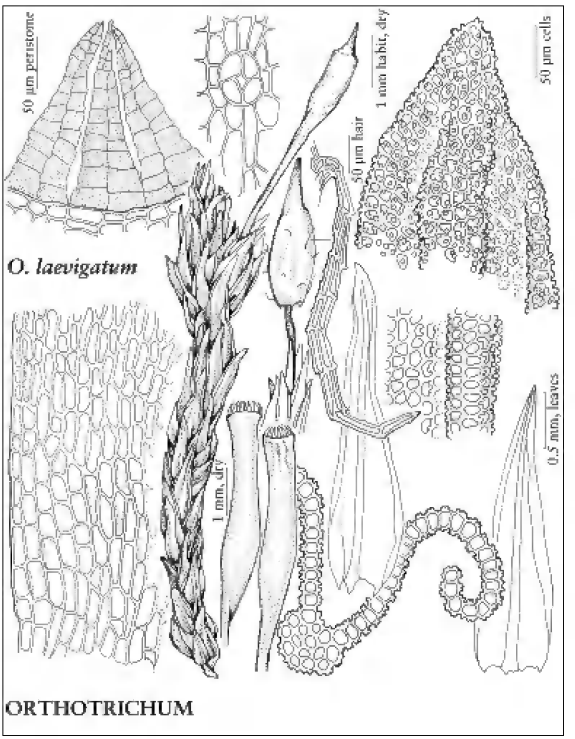
Fremont Co.: *Vitt 35377* as cited above (MO), "On vertical ledges of calcareous rock in seasonally wet stream and on dry outcrops near stream in *Pseudotsuga menziesii-Pinus contorta-Pinus flexilis* forest," 5 Jun 1990, *Vitt with Hastings s.n.* Park Co.: 6500 ft, granite, "new to Wyoming," *Hermann 20029* (RM).

Orthotrichum laevigatum Zett., Öfvers. Kongl. Vetensk.-Akad. Förh. 19: 363. 1862.
Orthotrichum hainesiae Aust.
Orthotrichum kingianum Lesq.
Orthotrichum laevigatum fo. *macounii* (Aust.) Lawt. & Vitt in Lawt.
Orthotrichum laevigatum var. *kingianum* (Lesq.) Grout
Orthotrichum lonchothecium Macoun & Kindb.
Orthotrichum macounii Aust.
Orthotrichum macounii var. *lonchothecium* (Macoun & Kindb.) Grout
Orthotrichum raui Aust.
Orthotrichum roellii Vent.
Orthotrichum roellii subsp. *schlotthaueri* (Vent.) Kindb.
Orthotrichum roellii subsp. *stenocarpum* (Vent.) Kindb.
Orthotrichum schlotthaueri Vent.
Orthotrichum speciosum var. *brevicaule* Lesq.
Orthotrichum speciosum var. *hainesiae* (Austin) Paris
Orthotrichum speciosum subsp. *laevigatum* (Zett.) J.J. Amann
Orthotrichum speciosum var. *polyanthum* Lesq.
Orthotrichum speciosum var. *polycarpum* Lesq. & James
Orthotrichum speciosum var. *raui* (Austin) Lesq. & James

Wyoming (FNA, Vol. 28, 2014). (As *O. macounii*) Wyoming, Flowers (1973). (As *Orthotrichum macounii* Aust.) Yellowstone Natl Park, Porter (1937). (As var. *lonchothecium* (Müll. Hall. & Kindb.) Grout.) Washakie Co., Porter (1937). Wyoming, Flowers (1973). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Big Horn Co.: Middle Ten Sleep Creek, N side of a great rock, 1 Aug 1901, *Goodding 479* (MO); UTM 13 326560 E 4898333 N, on rock, subalpine lake margin & surrounding forest of *Pinus contorta* & *Abies lasiocarpa*, with *Vaccinium scoparium*, SE shore of East Tensleep Lake, Bighorn Natl. Forest 9734 ft (2968 m), 25 Aug 2005, *Lenz 2148* (MO). Campbell Co.: Richelle HilLs, head of Wildcat and S Fork Keyton Creeks, T 41 N, R 69 W, Sec. 11, 12, 1500–1550 m, natural brick and sandstone of Fort Union formation, *Pinus ponderosa-Juniperus*-sagebrush associations, N-facing cliffs, 5–8 Jun 1975, *Weber B–49248,* Powder River Basin Coal Strip Mine Ecological Impact Inventory (MO). Fremont Co.: Bridger-Teton Natl Forest on US26 & US287, between Moran & Dubois ca. 9000 ft, alpine meadow, much herbage, wet with flowing streams, granite outcrops, N slopes of knoll, with *Tortula ruralis*, *Eckel 9308102* (BUF); (as fo. *macounii*) 9300 ft, *Hermann 25299* (RM). Johnson Co.: *Eckel 24586;* T52N, R 84 Sec. 25, 5600–6000 ft, *Odasz 1264* (RM). Lincoln Co.: 6700 ft, *Hermann 25601* (RM). Park Co.: 6500 ft, *Hermann 20032 1/2* (RM); Beartooth Plateau, Cooke City to Red Lodge Hwy, granitic ridges with *Picea* and *Pinus flexilis*, vicinity of Long Lake and lower Sheepherder Lakes, 2900 m, on rock outcrops, 20 Aug 1973 *Weber B–44240* (RM, COLO); 7500 ft, *Hermann 20054* (RM); dry, shaded rock under open canopy of Douglas fir, at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1795* (MO); T55N R104W, sec 5,6,7, 5600–6000 feet*; Hartman 20603 a & b*, with *O. hallii* and *O. rupestre* (RM). Sheridan Co.: 5400–6000 ft, *Hartman 9402* (RM, BUF); T 56 N, R 90 W, Sec. 31& 32, 8800–8700 ft, Big Horn Mountains, *Odasz no .866*; Big Horn Mts., T57N R 87W S29; Freezeout Stock Trail, Sec. 29 & 30, E exposure on limestone and chugwater redbeds, mostly open with a few groves of *Pinus ponderosa*; 5400–6800 ft; 5400 ft, 7 Aug 1979, *Hartman 10814* (RM). Sublette Co.: 10,300 ft, *Rolston 86024*, as fo. *macounii* (CSU); 7950 ft, *Hermann 25322* (RM). Teton Co.: (as fo. *macounii*) 7000 ft, *Hermann 25551* (RM); Teton Natl Park, between Jenny Lake and Lake Solitude, granite, vertical, 7000–7800 ft, 14 Aug 1953, *Welch 16239* (MO). Yellowstone Natl Park: on the vertical face of a great shaded rock, Druid Peak, 12 Jul 1899, *Nelson & Nelson 5791,* capsules

dehisced & old, exsiccat Plants of Yellowstone Natl. Park det. Holz. (RM); on rock at Lower Falls—Yellowstone Falls, 21 Aug 1938, *Bartley & Pontious 8* (RM) ; W of Bear Tooth Butte, along Clark Fork of Yellowstone River, 6940 ft, 22 Aug 1953, *Lawton 1997* (MO).



Courtesy FNA Association, FNA 28, 2014

This species is rather a distinctive *Orthotrichum*, with its thick-walled nodose basal cells, recurved margins, long-exserted unribbed capsules. The epithet refers to a capsule that is not ribbed when dry, as is usual in the genus, but essentially smooth. The character most emphasized to separate this species from *O. rupestre* is the length of the seta: for *O. laevigatum,* the capsule is plainly exserted, the seta 2–5 mm long usually longer than the exserted capsule. The stems are relatively shorter (1–4 cm long). The capsules are smooth or slightly plicate distally; exothecial cells homogeneous, rarely slightly ribbed just below the mouth. Exothecial cells not much differentiated among the ribs. The calyptrae can be more copiously pilose than as illustrated here.

In *O. rupestre* the capsule is immersed to emergent, the seta is usually less than 2 mm long (0.8–1.2 mm: less than the length of the capsule), the stems are quite a bit larger (3–8 mm long), the seta usually less than 1 mm long . Note that *O. rupestre* is very variable, sometimes the capsule length is hard to see because the neck and the tip of the seta cannot. be distinguished. The capsule is slightly or distinctly 8-ribbed 1/2–2/3 the length and ranges from nearly smooth to distinctly ribbed throughout, or ribbed only in the upper part when dry; the exothecial cells are often differentiated among the ribs. Both these species often grow with *O. hallii*, q.v., a species with 2(–3)-stratose

leaves. *Orthotrichum anomalum* also has exserted sometimes smooth capsules, but its stomata are immersed and the basal leaf cells are rectangular and not nodulose.

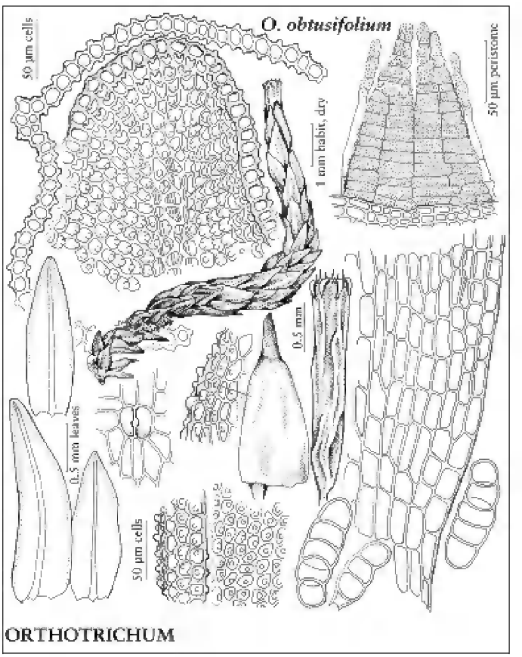
Orthotrichum pylaisii is very similar to *O. laevigatum:* see discussion under the former species. The erect peristome teeth of *O. laevigatum* will separate this species from the strongly reflexed teeth of *O. pylaisii.* The long-decurrent, often excavate nature of the alar cells of both these species, and the red to orange coloration at the insertion occurs in both these species.

A specimen of *Orthotrichum laevigatum* from Sheridan Co. (Odasz 1133 Big Horn Mtns.) was strikingly similar to the description of *O. macounii* Aust. as described and figured by Flowers (1973): rather than the bluntly acute or obtuse leaf apex typical of *O. laevigatum*, the apices of all the cauline leaves were long acuminate to a slender, hair-like tip. The capsules were long and very smooth, the plants strongly yellow. *Orthotrichum macounii* intergrades with *O.laevigatum* so extensively that the former is synonymized with the latter.

Orthotrichum obtusifolium Brid., Muscol. Recent. 2(2): 23. 1801.
Nyholmiella obtusifolia (Brid.) Holmen & E. Warncke
Orthotrichum inflexum Müll. Hal.

Wyoming; "*Orthotrichum obtusifolium* is a pronounced xerophyte growing only in pioneer situations" (Vitt, FNA Vol. 28, 2014).

Crook Co.: Black Hills: 6.4 km NNE of Warrens Peaks, along Beaver Creek, deciduous woods along creek, moss shaded trunk of *Acer negundo,* 21 May 1977, *Churchill 8739* (MO).



Courtesy FNA Association, FNA 28, 2014

Orthotrichum pellucidum Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 23: 549. 1867.
Orthotrichum cupulatum var. *jamesianum* (James) Lawton
Orthotrichum jamesianum James

Wyoming (FNA, Vol. 28, 2014). (As *Orthotrichum cupulatum* var. *jamesianum* (Sull.) comb. Nov (Lawton). Teton Natl Forest, Snake River, Red Canyon, *Ellison 943–3* (UT), Vitt (1973). Teton Natl. For., Snake Riv., Red Canyon, *Ellison 943–3* (UT), Vitt (1973).

Albany Co.: Laramie Mtns., Roger Canyon, ca. 8 air mi NE of Laramie, 2400 m, limestone outcrops with *Cercocarpus montanus*, 7 Jun 1993, *Buck 23165*, capsules old, some with calyptrae (NY). Fremont Co.: 7800 ft, *Hermann 25532* (RM); Shoshone Natl Forest in Wind River Mns., along Hwy 131 SW of Lander, between Sink State Park and Frye Lake 8.4 km NE of Frye Lake, 2260 m, on large, pitted, dry limestone boulders in *Pinus contorta-P. flexilis-Pseudotsuga menziesii* forest, 5 Jun 1990, *Vitt & Hastings 35381* (MO). Park Co.: T55N, R 104 W Sec., 7, N, 6800–7000 ft, *Hartman 12594;* 6900–7800 ft, *Hartman 21047* (RM). Sheridan Co.: Moist limestone, vertical rock face, calcareous region, Big Horn Natl Forest, T57N, R89W Section 27, 16 Jun 1992, *McKee 92–017*, c.fr., calyptrate, immature capsules (BUF, RM).

Among the Sheridan Co. specimens there were occasionally 16-ribbed capsules (alternate ribs less conspicuous than the main ones and often appearing to be 8-ribbed). These capsules were correspondingly larger. The leafy stems are somewhat glaucous in appearance, the leaves rather broad throughout and oblong-lanceolate to ligulate with broad apices often incurved when dry like a little fist. The stomata are immersed and the cells of the capsule are thick-walled and colored on the ridges, thinner and nearly hyaline in the furrows. Shorter stems are so densely foliose as to appear rosulate. The papillae are large, bi-fid examples mixed with large single ones. The lamina is not supposed to be bistratose in streaks in this species as described for *O. cupulatum.*

Orthotrichum pellucidum grows on rocks (calcareous) and the stems are short (to 1 cm or shorter; however, *O. pallens* and *O. pumilum* are "less than 0.5 cm long" (Lawton 1973) and grow on bark. One handy difference is that the calyptra of *O. pellucidum* is rather conspicuously hairy, whereas that of *O. pallens* is not hairy and that of *O. pumilum* is not or sparsely hairy (Weber & Whittmann 2007).

The glaucous character of *Orthotrichum pellucidum* is not often distinct (the leaves can have a pruinose look, like the surface of a grape) and its thickness appears to be due to the coarseness of the pappillae on the laminae.

[*Orthotrichum strangulatum* P. Beauv. has been reported from states W of the central states, but apparently without merit (Vitt, FNA Vol. 28, 2014). It is distinctive in the leaf margins multistratose (2–8 layers).]

Orthotrichum praemorsum Vent., Bot. Centralbl. 44: 418. 1890.
Orthotrichum affine ssp. *praemorsum* (Vent. in Roell) Kindb.
Orthotrichum arcticum var. *praemorsum* (Vent. in Roell) Wijk & Marg.
Orthotrichum idahense Card. & Thér.
Orthotrichum microblephare var. *praemorsum* (Vent. in Roell) Grout

Wyoming; "*Orthotrichum praemorsum* is rare, known only from a few collections" also from California, Nevada and Washington (Vitt, FNA Vol. 28, 2014). Lawton notes Idaho, Wyoming and Nevada (1971). Patria, Rocky Mountains: ad rupes Yellowstone Natl Park (Wyoming 1491) (Roell 1893). "*Orthotrichum praemorsum* Vent. on rocks in Yellowstone Natl. Park, Wyom." (Roell 1893).

"The type collection of this species was taken from Yellowstone Natl Park by Roell in about 1890. No other collection is known," Porter (1935). Yellowstone Natl Park, Porter (1937).

Yellowstone Natl Park: Yellowstone Falls, 7500 ft, 14 Aug 1897, *Rydberg & Bessey s.n.*, c.fr., old young middle (NY).

Vitt (1973) mentioned these specimens: Yellowstone Natl Park, near Cascades, Firehole River, *Flowers 3849* (UT, WTU). Vitt indicated this was endemic to the western U.S., "Probably restricted to the higher elevations in Pine forests." It grows on rock in dry areas, whereas *O. affine*, close to it, grows "on trees in mesophytic areas."

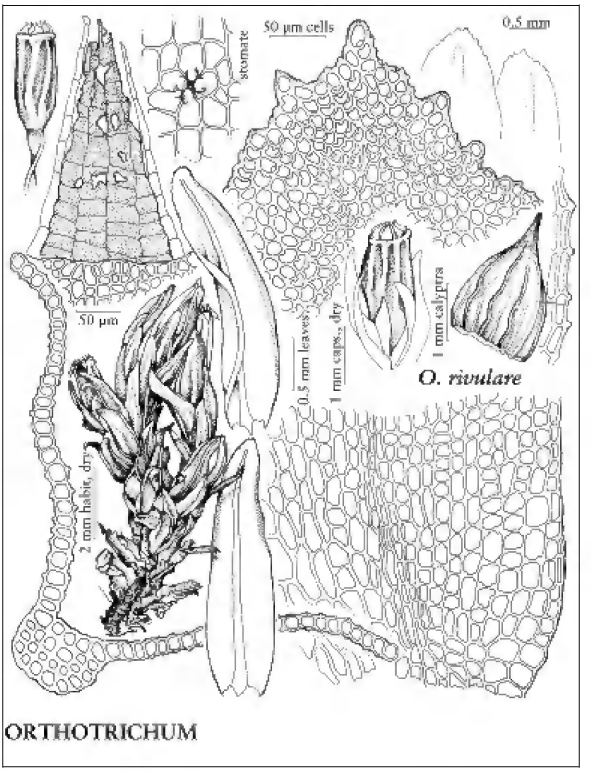
Orthotrichum pylaisii Brid., Bryol. Univ. 1: 722. 1826 (as pylaisaei)
Orthotrichum arcticum Schimper
Orthotrichum arcticum subsp. *blyttii* (Schimp.) Kindb.
Orthotrichum arcticum var. *groenlandicum* (Berggren) Mönk.
Orthotrichum blyttii Schimper
Orthotrichum blyttii subsp. *arcticum* (Schimp.) Macoun
Orthotrichum blyttii var. *arcticum* (Schimp.) I. Hagen
Orthotrichum blyttii var. *groenlandicum* (Berggren) C.E.O. Jensen
Orthotrichum blyttii subsp. *microblephare* (Schimp.) Macoun
Orthotrichum blyttii var. *microblephare* (Schimp.) C.E.O. Jensen
Orthotrichum groenlandicum Berggren
Orthotrichum idahoense Card. & Thériot
Orthotrichum pylaisii subsp. *arcticum* (Schimp.) Kindb.
Orthotrichum pylaisii subsp. *groenlandicum* (Berggren) Kindb.
Orthotrichum pylaisii subsp. *microblephare* (Schimp.) Kindb.
Orthotrichum rhabdophorum Vent.

Wyoming (FNA, Vol. 28, 2014). Yellowstone Natl Park: *Rydberg & Bessey 1897* (NY), Vitt (1973). Vitt (1973): listed for Wyoming. Lawton (1971) does not mention this; see Vitt (1973: 77 ff.).

The capsules are commonly exserted, the top of the seta exposed. Stomata superficial, the basal cells nodose. The leaves of *Orthotrichum pylaisii* may be red at the insertion, with decurrencies, sometimes quite long, and moderately with excavate cells in the alar region. The basal cells are conspicuously nodose—a character most associated with superficial or phaneropore stomata in the capsules. Stomata in this species are located in a broad region mid-capsule. The 8 exostome teeth are so strongly reflexed as to appear glued to the outer mouth of the capsule where they split (hence becoming 16). The cells of the exothecium (capsule) are differentiated in rows to mid capsule (reflecting the ribbed condition). In *O. laevigatum* many of the exostome teeth are erect and the exothecial cells are not or little differentiated as the capsule is generally unribbed (smooth). Note, however, that the capsules of *O. laevigatum* are smooth, but often somewhat ribbed or plicate to strongly furrowed in the same collection.

Orthotrichum rivulare Turner, Muscol. Hibern. Spic., 96, plate 8. 1804.

Wyoming; "Exposed tree roots, base of trees along streams, siliceous boulders at edges of streams and rivers, frequently inundated rock, aquatic habitats; low to moderate elevations (0–1000 m)" (Vitt, FNA Vol. 28, 2014). Lawton (1971).



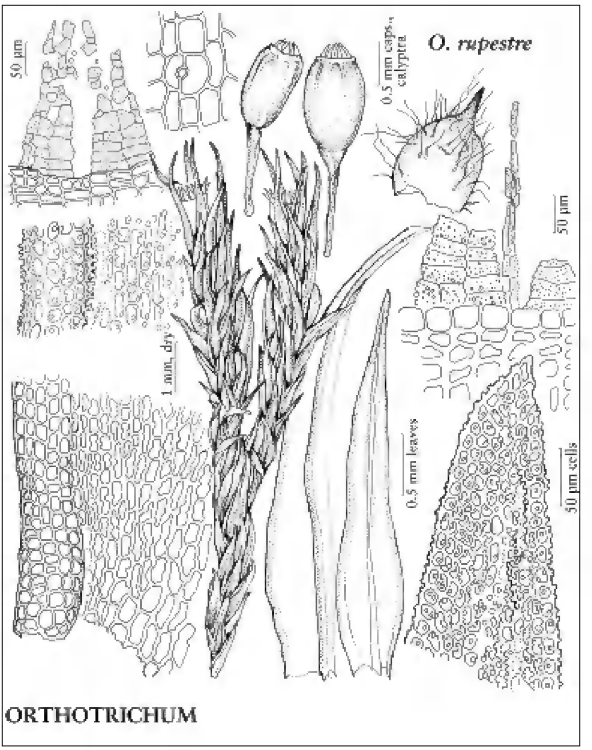
Courtesy FNA Association, FNA 28, 2014

Orthotrichum rupestre Schleicher ex Schwägr., Sp. Musc. Frond. Suppl. 1(2): 27, plate 53 (top). 1816.
Dorcadion rupestre (Schleicher ex Schwägr.) Lindb.
Orthotrichum bullatum Müll. Hal.
Orthotrichum californicum Vent.
Orthotrichum douglasii Duby
Orthotrichum macfaddenae R.S. Williams
Orthotrichum rupestre var. *globosum* (Lesq.) Grout
Orthotrichum rupestre var. *macfaddenae* (R.S. Williams) Grout
Orthotrichum texanum Sull. & Lesq.
Orthotrichum texanum var. *globosum* Lesq.

Wyoming (FNA, Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1486, 1487, 1489*) (Roell 1893). Albany, Carbon Cos., Yellowstone Natl Park. The var. *sturmii* (H. & H.) from Big Horn County, (*Goodding 479*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: crevices in vertical face of granite bluff on Sand Lake Rd., 1.3 mi NW of Rte. 130, 8500 ft, 3 mi W of Centennial, 5 Aug 1962, *Hermann 17751* (RM); Medicine Bow Natl Forest,

Laramie Range, Blair Picnic Area, N of Interstate 80, 21 Aug 1987, *Crosby 15348A* (MO). Bighorn Co.: UTM 13 325004 E 4894900 N, on large boulder, lower end of large meadow, along East Tensleep Crk., ca. 1.7 air mi NE of Meadowlark Lake, Bighorn Natl Forest; 9018 ft (2749 m), 25 Aug 2005, *Lenz 2165* (MO). Carbon Co.: 14.8 km E of jct. of Hwys 230 and 130 on Hwy. 130 between Centennial and Saratoga, 41°21'N 106°32'W, 2350 m, on dry acidic rock outcrop in *Artemisia-Juniperus* scrub vegetation mixed with *Amelanchier* shrubs, 5 Jul 1990, *Vitt s.n.* (ALTA). Fremont Co.: Shoshone Natl Forest in Wind River Mts. along Hwy 131, SW of Lander, between Sinks Canyon State Park and Frye Lake; 10.0 km NE of Frye Lake, 2200 m, on vertical ledges of calcareous rock in seasonally wet stream and on dry outcrops near stream in *Pseudotsuga menziesii—Pinus contorta—Pinus flexilis* forest, 5 Jun 1990, *Vitt 35376* (MO); Shoshone Natl Forest in Wind River Mts. along Hwy 131, SW of Lander, between Sinks Canyon State Park and Frye Lake; just E of Northern Meadows Reservoir (W of Frye Lake), 2650 m, large boulder meadow with stunted *Populus tremuloides*, 5 Jun 1990, *Vitt 35390* (MO). Johnson Co.: Big Horn Natl Forest, Klondike Ranch Quadrant, (54) T49N R83W, Sec., 28, 6600 ft, rocks in *Aspen* grove, 20 Aug 1992, *Andrus s.n.* (BING, BUF). Park Co.: 6500 ft, *Hermann 20031* (RM); T55N R104W, sec 5,6,7 5600–6000 feet; *Hartman no 20603 a & b,* with *O. hallii* and *O. laevigatum* (RM). Sublette Co.: on granite, Bridger Natl Forest ca. 6.5 mi NE of Pinedale, 13 Sep 1977, *Allen 421.* Yellowstone Natl Park: just E of western jct. of Blacktail Deer loop road, Blacktail Deer Plateau, 2280 m,



Courtesy FNA Association, FNA 28, 2014

forming extensive mat on N side of 1.5 m high siliceous rock outcrop in open *Pseudotsuga menziesii* forest, *Tortula ruralis* and *Orthotrichum laevigatum* abundant on other rock surfaces, *Vitt 27,* Orthotrichaceae Boreali-Americanae Exsiccatae Fasciculus Nos. 21–30 1981 (label data misapplied to 30, *Macrocoma tenue* subsp. *sullivantii,* Christie, in sched.)

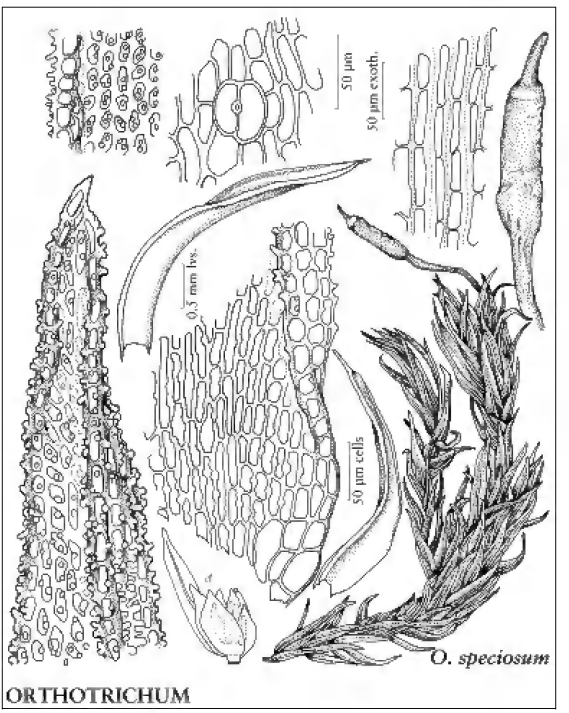
The leaf apex is a stumpy, broad acutation; frequently there is a broad leaf decurrency, and the basal angles are often excavate and thinner walled. The capsule is only emergent and still enclosed among the leaves to the middle of the capsule, the seta hidden in the leaves. *Orthotrichum laevigatum* and (*O. anomalum*) have completely exserted capsules with the seta evident.

Orthotrichum speciosum Nees in J. Sturm et al., Deutschl. Fl. 2 (17): 5. 1819.
Orthotrichum killiasii Müll. Hal.
Orthotrichum speciosum subsp. *killiasii* (Müll. Hal.) Kindb.
Orthotrichum speciosum var. *killiasii* (Müll. Hal.) Vent.

Wyoming (FNA, Vol. 28, 2014). Albany Co. (*Porter 865*), (Yellowstone Natl Park), Porter (1935); Yellowstone Natl Park, Firehole River, *Chase 175* (NY), Vitt (1973).

Sublette Co.: 7950 ft, *Hermann 25324* "new to Wyoming" (RM).

The species is separated from *O. laevigatum* "by the presence of thick endostome segments, recurved exostome teeth, and lack of a preperistome," Vitt (1973). It is "lightly ribbed, exserted capsules with eight recurved exostome teeth and eight stout, thick, endostome segments," Vitt (1973).



Courtesy FNA Association, FNA 28, 2014

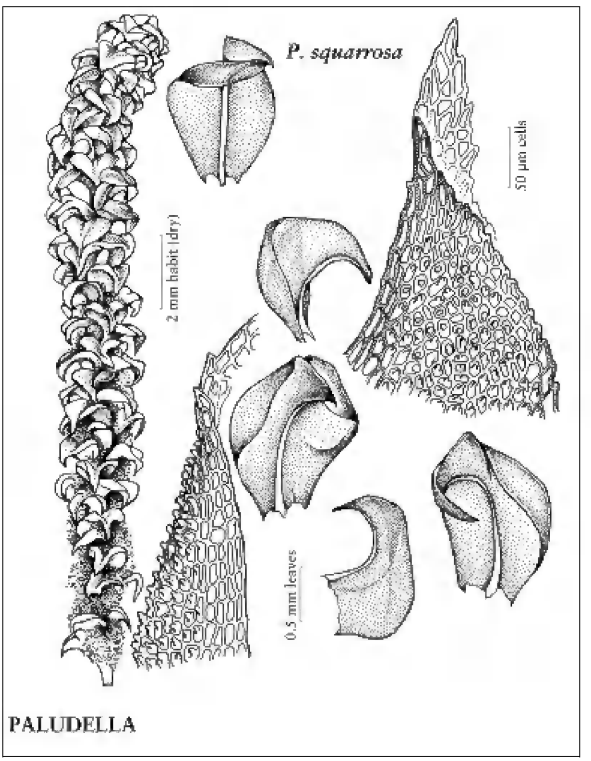
[*Orthotrichum urnigerum* Myr., excluded]

This species has been excluded from North America by Anderson et al. (1990), and it is not cited in FNA Vol. 28, 2014. Wyoming: Yellowstone Natl Park (*1884*), Roell (1893).

PALUDELLA Ehrhardt ex Brid., Muscol. Recent., suppl. 3: 72. 1817. (Meesiaceae)

Paludella squarrosa (Hedw.) Brid., Muscol. Recent., suppl. 3: 72. 1817.
Bryum squarrosum Hedw., Sp. Musc. Frond. 186, plate 44, figs. 6–11. 1801.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014). Lawton (1971) citation. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010). Johnson Co., in association with *Warnstorfia tundrae*, Lenz (2006).



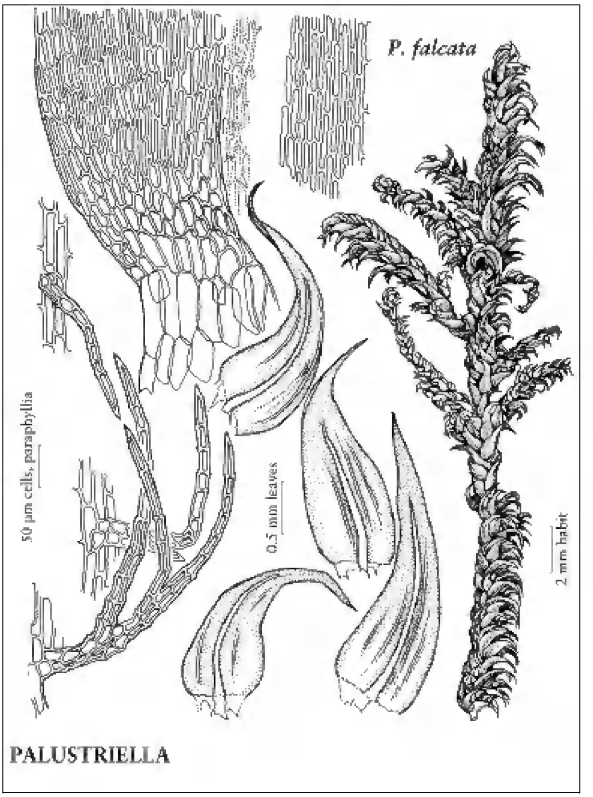
Courtesy FNA Association, FNA 28, 2014

PALUSTRIELLA Ochyra, J. Hattori Bot. Lab. 67: 223, figs. 5, 6. 1989. (Amblystegiaceae)

Palustriella commutata (Brid.) Ochyra, in North America = Palustriella falcata (Brid.) Hedenäs, q.v.

Palustriella decipiens (De Not.) Ochyra, see Palustriella falcata (Brid.) Hedenäs

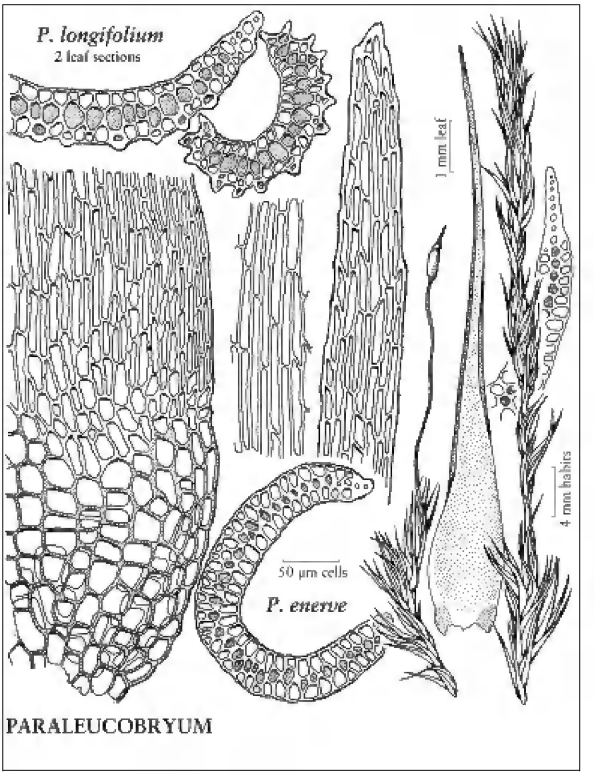
Palustriella falcata (Brid.) Hedenäs, Bryophyt. Biblioth. 44: 136. 1992.
Hypnum falcatum Brid., Muscol. Recent. 2(2): 63, plate 1, fig. 6. 1801.
Cratoneuron commutatum (Hedw.) Roth
Cratoneuron commutatum var. *falcatum* (Brid.) Mönk.
Cratoneuron commutatum var. *sulcatum* (Lindb.) Mönk.
Cratoneuron falcatum (Brid.) G. Roth
Cratoneuron falcatum var. *williamsii* (Grout) Flow.
Cratoneuron papillosum Grout
Cratoneuron williamsii Grout



Courtesy FNA Association, FNA 28, 2014

Wyoming; "*Palustriella falcata* is widespread in the northwest, less common in the northeast, and absent in northern-central and high-Arctic areas. The species has been misunderstood in North America; most specimens identified as *P. commutata* (Hedw.) Ochyra (synonym *Cratoneuron commutatum* (Hedw.) G. Roth), and the few *P. decipiens* (Notaris) Ochyra records, belong to this species" (Hedenäs, FNA Vol. 28, 2014). (As *Palustriella commutata*) Brooklyn Lake, Albany County (*Porter 1457*); Union Pass, Fremont County (*Nelson 1078*), Porter (1935). Albany, Fremont

cos., Porter (1937). Teton Co., Spence (1985). (As *Cratoneuron falcatum* (Brid.) Roth.) "Falls of Libby Creek," Albany County (*Porter 1375*), Porter (1935). (As *Cratoneuron falcatum* (Brid.) Roth.) Albany Co., Porter (1937). (As *Palustriella falcate* and also *P. decipiens*) Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 27, 2007

(As *Palustriella commutata*) Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1937* (BUF). Park Co.: W end of Bear Tooth Lake, 20 Aug 1953, 1956, *Lawton s.n.* (WTU). Yellowstone Natl Park: (as *Hypnum aduncum* Hedw.) in a bog, Obsidian Creek, *Nelson & Nelson 6106,* exsiccat Plants of Yellowstone Natl. Park det. Holz. (the material was typical, numerous paraphyllia, strongly plicate leaves, falcate, leaves ovate-lanceolate, irregularly branching) (RM). Sublette Co.: 8000 ft, *C.L. & M. Porter 9682* (RM); Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May 1989 *Andrus 7801a* (BING).

(As *Palustriella decipiens)* Albany Co.: streamlet in mountain meadow, boulder, 10,000 ft, *Hermann 17725* (RM). Park Co.: S slope of Bear Tooth Butte, 23 Aug 1953, *Lawton 2051,* c.fr. (WTU). Teton Co.: E of Teton Pass, 15 Aug 1953, *Lawton 1778* (WTU).

The basal laminal cells are papillose dorsally from the upper cell ends.

PARALEUCOBRYUM (Lindb. ex Limpr.) Loeske, Allg. Bot. Z. Syst. 13: 162. 1907. (Dicranaceae)
Dicranum subgen. *Paraleucobrym* Lindb. ex Limpr. in G. L. Rabenhorst et al., Krypt.-Fl. ed. 2, 4(1): 373. 1886.

Paraleucobryum enerve (Thed.) Loeske, Hedwigia 47: 171. 1908.
Dicranum enerve Thed. in C. J. Hartman, Handb. Skand. Fl. ed. 5, 393. 1849.
Dicranum albicans B.S.G.

Wyoming (FNA, Vol. 27, 2007). Usually in arctic or alpine regions. British Columbia, Alberta, Montana: Alaska, Colorado. Park Co., with *Pogonatum urnigerum* (Kosovich-Anderson 2011b). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: alpine bog, 3250 m, *Weber B–44256* (COLO, RM).

PHILONOTIS Brid., Bryol. Univ. 2: 15, plate 6, fig. 5. 1827. (Bartramiaceae)
Bartramidula P. Bruch & W.P. Schimper

The species in the genus in Wyoming apparently represent one polymorphic species. The names seem to correspond to stages in the lengthening of the stem:early stages are *Philonotis fontana* var. *pumila*. A subsequent stage may be var. *heterophylla*. *Philonotis americana* var. *torquata* looks like *P. fontana* var. *falcata* or intergrade depending on the degree of ranking of the leaves in the mid-section of the stem. In the end one might want to re-analyze the *Philonotis* specimens from RM with the aid of illustrations.

Philonotis caespitosa Jur. = Philonotis fontana (Hedw.) Brid.

Philonotis fontana (Hedw.) Brid., Bryol. Univ. 2: 18. 1827.
Mnium fontanum Hedw., Sp. Musc. Frond. 195. 1801.

Var. **fontana**
Philonotis caespitosa Jur.
Philonotis fontana var. *caespitosa* (Jur.) Limpr.
Philonotis fontana var. *falcata* (Hook.) Brid.
Philonotis fontana var. *heterophylla* Dismier

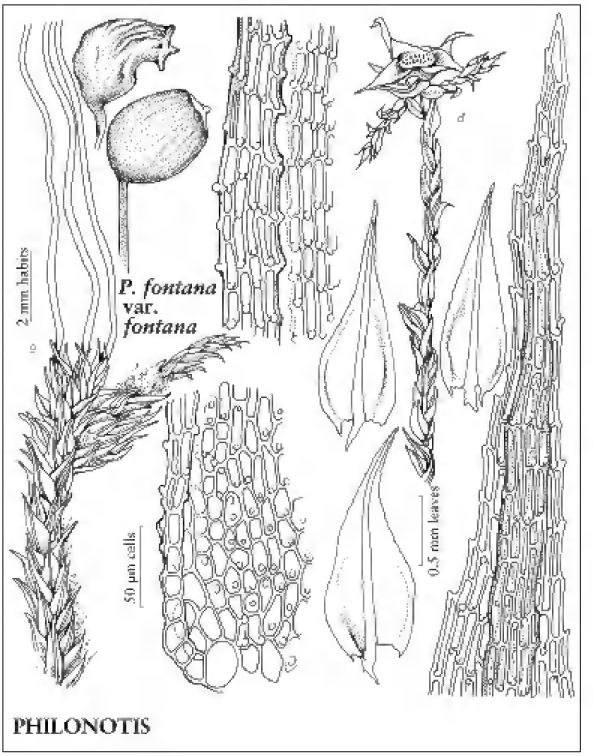
Wyoming (FNA, Vol. 28, 2014). (As *Philonotis fontana*) Wyoming: Yellowstone Natl Park (*1495, 1497, 1503*) (Roell 1893). Albany, Carbon, Sheridan, Teton cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: La Plata Mines, *Nelson 1800* (RM). Carbon Co.: 9500 ft, *Hermann 17179* (RM). Sheridan Co.: 8400 ft, *B.E.Nelson 4318* (RM, BUF); Dome Lake, 16 Jul 1896, *Nelson 8826* , in packet of *Bryum (Rosulabryum) capillare*, with *Drepanocladus uncinatus* (RM). Sublette Co.: Bridger Wilderness, Wind River Range 2., Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at south end of lake with *Climacium americanum, Bryum pseudotriquetrum*, 14 May 1989, *Andrus 7789* (BING).

(As var. *caespitosa* (Jur.) Schimp.) Montana; Minnesota, Ontario; Quebec, New England.

(As var. *caespitosa* (Jur.) Schimp.) Albany Co.: steep, wet, peaty bank of inlet, Towner Lake, 10,000 ft, Medicine Bow Mts., 9 mi W of Centennial, 5 Aug 1962, *Hermann 17768 1/2* (RM). Park Co.: wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1731* (BUF).

(as var. *falcata* (Hook.) Brid.) Albany Co.: Centennial Valley, 18 Aug 1895, *Nelson 1756*, c.fr. (RM). Yellowstone Natl Park: on the steep slopes near the river, Lewis River, *Nelson 6381* (changed from *6391*) (RM).



Courtesy FNA Association, FNA 28, 2014

Var. **americana** (Dismier) Flowers ex H.A. Crum, Bryologist 72: 244. 1969.
Philonotis americana Dismier, Mém. Soc. Bot. France 17: 35. 1910.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014). (As *Philonotis americana* (Dism.) Dism. var. *americana*: Lawton.)

Albany Co.: Sherman & Buford, spring bog, *Macbride 2548* (RM). Carbon Co.: Sierra Madre Mtns, along Haggarty Creek, 9680 ft, in wet meadow by creek, 11 Jul 1991, *Kastning-Culp*

3073, c. young fr., teratological (double capsules) (BUF, RM). Park Co.: pond edge, 7500 ft, *Hermann 20047*, this specimen corresponds nicely with Lawton's illustrations for *P. americana* var. *torquata* (Ren. & Geh.) Flow. in Grout, the leaves are distant on the stem (RM)). Washakie Co.: Big Horn Mtns., ca. 33.5 air mi SE of Tensleep, 14.5 mi SSE Big Trails along Cherry Creek, , 7400 ft, 10 Jul 1979, *B. Nelson 3445,* c.fr., operculate (BUF, RM). Yellowstone Natl Park: *Nelson & Nelson 6062* (det. Holtzinger) (RM).

var. **pumila** (Turner) Brid., Bryol. Univ. 2: 20. 1827
Bartramia fontana var. *pumila* Turner, Muscol. Hibern. Spic., 107, plate 10, fig. 1. 1804.

Wyoming (FNA, Vol. 28, 2014).

Big Horn Co.: Big Horn Natl Forest, Lake Solitude Quadrant. T50N R87W, Sec. 12, 9600 ft, marshy area just W of Lily Lake, 5 Aug 1992. *Zacharkevics s.n.,* plus *Drepanocladus aduncus* var. *kneifiii (*BING, BUF, RM). Fremont Co.: 8400 ft, Absaroka Range, *Hermann 25506* (RM). Lincoln Co.: Salt River Range, 6400 ft, *Hermann 25586* (RM). Park Co.: 3250 m, *Weber B–44262* (COLO, RM). Sheridan Co.: Wolf Creek, 12 Jul 1896, *Nelson 2317*, c.fr. (RM). Yellowstone Natl Park*: Porter 1675* (RM).

This variety is characterized by the long excurrent costa. "Pumilus" implies a dwarfed or shortened aspect. These specimens are very robust in general, at least as large as the typical variety. Note Crum and Anderson (1981: 655) write they saw a specimen from Wyoming.

Var. **heterophylla** Dismier, hom. illeg.

Park Co.: 10,000 ft, tundra, *Hermann 20074* (RM). Yellowstone Natl Park: Exsiccat, in a springy bog, Obsidian Creek, 24 Jul 1899, *Nelson & Nelson 6110* (RM). Holzinger identified this specimen as var. *alpina*, apparently without noticing the dimorphous leaves.

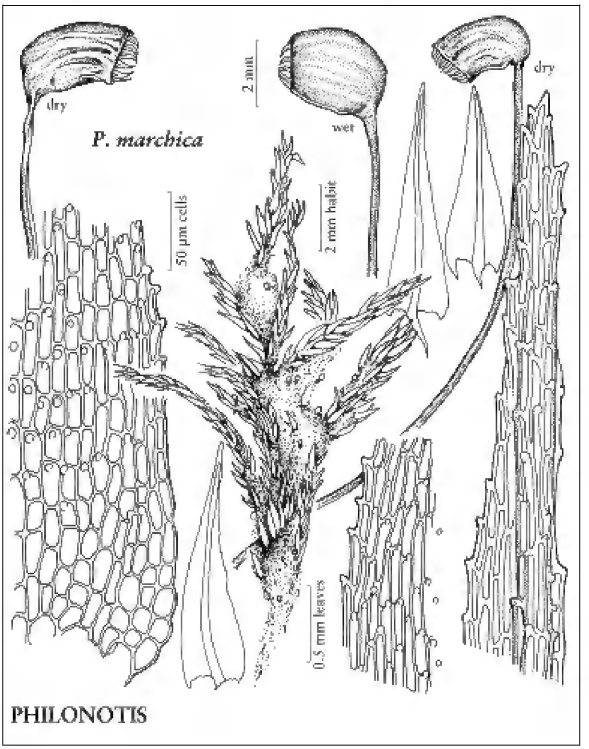
Leaves dimorphic, the lower ones tyical, the upper ones shorter with margins plane or revolute only at the base; leaf cells short—Lawton (1971: 212).

Philonotis marchica (Hedw.) Brid., Bryol. Univ. 2: 23. 1827.
Mnium marchicum Hedw., Sp. Musc. Frond. 196. 1801.
Philonotis muehlenbergii (Schwägr.) Brid.

Wyoming (FNA, Vol. 28, 2014). (As *Philonotis muehlenbergii*) Wyoming: Yellowstone Natl Park (*1552*) (Roell 1893). (As *Philonotis mohriana* Lesqu. & James) Battle Lake Mountain, Carbon County (*Nelson 4202*, in part.) Not in Anderson et al. (1990) checklist; no reference in FNA Vol. 28, 2014). However, *Philonotis Mohriana* (Müll. Hal.) A. Jaeg. (basionym *Bartramia mohriana* Müll. Hal. = *Breutelia mohriana* (Müll. Hal.) Broth.

Philonotis yezoana Besch. & Card., Bull. Soc. Bot. Genève, sér. 2, 1: 123. 1909.

Not reported for Wyoming in FNA Vol. 28, 2014; "Plants of *Philonotis yezoana* are easily recognized by their dark green color and centrally papillose laminal cells" (Griffin, FNA Vol. 28, 2014).) However, the species has been reported in a paper by Kosovich-Anderson & Weber in 2011. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Park Co.: SNF, Beartooth Plateau, Lake Creek: rapids, overlook "Lake Creek Waterfall," 50 m N of HWY 212, sheltered granite outcrops lining the waterfall, under the steep bank forested by *Pseudotsuga menziesii, Pinus contorta*, and *Picea* sp., on thin wet soil covering an outcrop's surface, shaded by spruce, in splash zone of the waterfall, 44°55.485–490'N, 109°41.670–675' W, 2280 m, 26 Aug 2009, *Kosovich-Anderson 5850* (COLO, DUKE); also steep rocky bank forested with *Picea* sp., over rock on a patch of soil, in splash zone of creek, 44°55.350–355' N, 109°42.430–435'W, 2100 m, 5 Aug 2010, *Kosovich-Anderson 8397* (no herbarium given), "the irregularly subquadrate and rectangular leaf cells with single massive central papillae on both surfaces, along with the dark green color, make the species easy to recognize," Kosovich-Anderson & Weber (2011).

PHYSCOMITRIUM (Brid.) Brid., Bryol. Univ. 2: 815. 1827. (Funariaceae)
Gymnostomum subg. *Physcomitrium* Brid., Bryol. Univ. 1: 97. 1826.

Physcomitrium hookeri Hampe, Icon. Musc., 30. 1844.
Gymnostomum latifolium Hook. in Drumm., Musci Amer., Brit. N. Amer., 16. 1828 not Brid.
Physcomitrium coloradense Britt.
Physcomitrium hians Lindb.
Physcomitrium latifolium (Hook.) Lindb.

Wyoming (FNA, Vol. 27, 2007). Montana, Wyoming; Utah; Manitoba, N. Dakota, Kansas, Minninnesota, Iowa, Nebraska, Wisconsin. (As *Physcomitrium coloradense* E. G. Britton) "A rare plant, collected but once. Stream bank, Millbrook." Albany County (*Porter 602*), Porter 193. (= *P. hookeri* Hamp. fide Crum & And. Bryologist 58: 10. 1955.) Campbell Co., Medina (1994).

Albany Co.: Millbrook, on soil, along a stream bank, 7600 ft, 20 May 1930 , *Porter 602*, c.fr., det. Grout as *P. coloradense* (TENN). Crook Co.: near Hulett, on soil, *Ownbey 556a*, Porter det. as *P. turbinatum*: "a form with some entire leaves, and costa somewhat excurrent!" but note huge revoluble annulus (TENN).

Physcomitrium pyriforme (Hedw.) Hampe, Linnaea 11: 80. 1837 1801.
Gymnostomum pyriforme Hedw., Sp. Musc. Frond., 38. 1801.
Physcomitrium californicum E. Britt.
Physcomitrium drummondii E. Britt.
Physcomitrium kellermanii E. Britt.
Physcomitrium megalocarpum Kindb.
Physcomitrium pygmaeum James
Physcomitrium turbinatum (Michx.) E. Britt.

Wyoming (FNA 28, 2014). (As *Physcomitrium turbinatum* (Michx.) Brid). Crook Co., Porter (1937) (hom. illeg. = *P. pyriforme* (Hedw.) Hamp. fid. Crum and Anderson, Bryologist 58: 5. 1955.)

The Porter citation from Crook County may be Marion Ownbey's specimen which is *P. hookeri*. See discussion above. This species does not occur in the Pacific Northwest. Flowers (1973: 311) includes it in Utah "from Manitoba to Utah and Texas." Crum and Anderson (1981) also speculated that the species does not occur W of the Great Plains.

PLAGIOBRYOIDES J.R. Spence, Phytologia 87: 24. 2005. (Bryaceae)

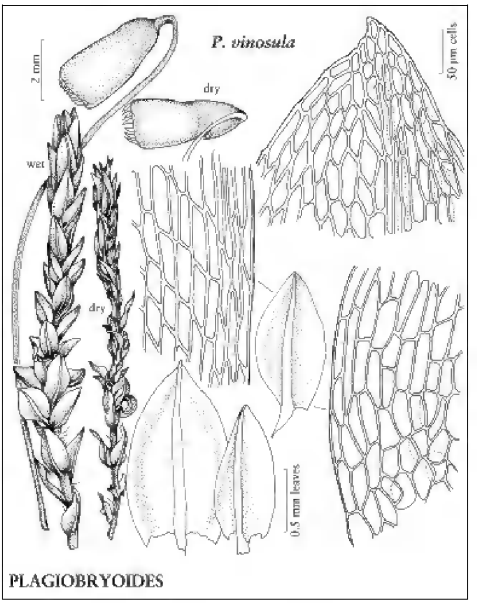
Plagiobryoides vinosula (Card.) J.R. Spence, Phytologia 91: 499. 2009.
Brachymenium vinosulum Card., Rev. Bryol. 38: 6. 1911.

Wyoming (FNA 28, 2014). (As *Brachymenium vinosulum*) Hot Springs, Thermopolis, Hot Springs State Park, E bank of the Big Horn River, Rainbow Terraces, on vertical surface of the terrace, washed with geothermal waters, 43°39' N, 108° 11'W, 4330 ft, (1320m), 28 Sep, 2003 Kosovich-Anderson, N 81 (RM,COLO,ASC), not seen. See Kosovich-Anderson and Spence (2008).

PLAGIOBRYUM Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 19: 606. 1863. (Bryaceae)
Zieria Schimper, Coroll. Bryol. Eur., 68. 1856, not Smith 1798.

Plagiobryum zieri (Dickson ex Hedw.) Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 19: 606. 1863.
Bryum zieri Hedw., Sp. Musc. Frond. 182, plate 44, figs. 1–5. 1801.
Pohlia zieri (Hedw.) Schwägr.

Wyoming (FNA, Vol. 28, 2014). "... the species is probably relictual in the Rocky Mountains south of the glacial maximum and presumably reached its current distribution during the Pleistocene. Populations south of the glacial ice sheets in the Rockies survived in refugia such as Colorado and expanded north during the Holocene" (Spence in Kosovich-Anderson & Weber 2011).



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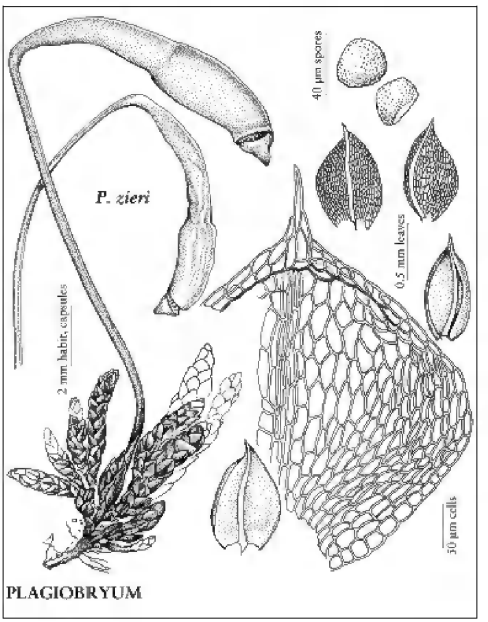


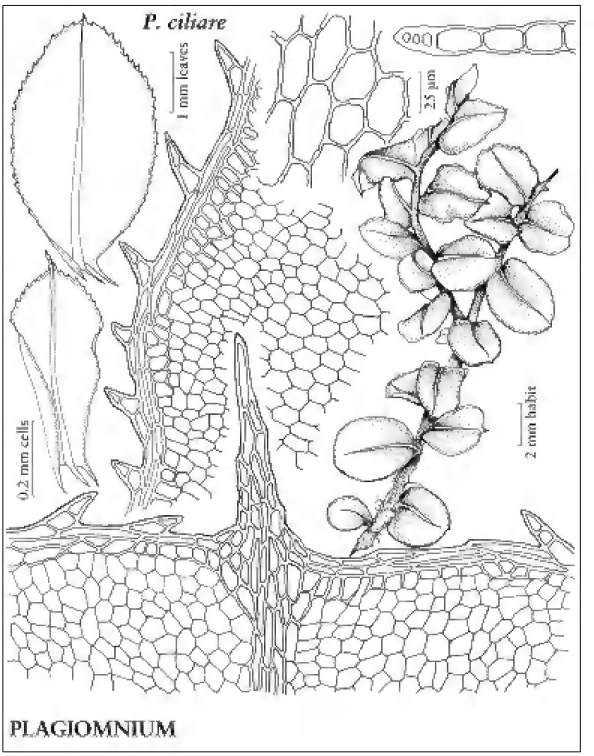
Courtesy FNA Association, FNA 28, 2014

Park Co.: SNF, foothills of the Beartooth Plateau, Clarks Fork of Yellowstone River, immediately SE of junction of Muddy Creek and Clarks Fork of Yellowstone River, gravel shore of Clarks Fork, massive granite boulders along the shore in seasonal splash zone, on wet clayey substrate in a rock crevice, 44°53.965–970'N, 109°40.310–315'W, 2000 m, 26 Aug 2009, *Kosovich-Anderson 5951* (ASC, COLO) "Det. by J. Spence"; also ca. 0.05 mi N-NE of Clarks Fork of Yellowstone River and Crazy Creek confluence, cataracts of Crazy Creek, seeping granite cliff, on a soaked humus soil, in shade, scattered among other bryophytes, 44°56.600–620'N, 109°46.555–565'W, ca. 6900 ft, (2100 m), 3 Aug 2010, *Kosovich-Anderson 7972* (without herbarium designation) (Kosovich-Anderson & Weber 2011).

PLAGIOMNIUM T. Kop.., Ann. Bot. Fenn. 5: 145, figs. 14, 15, 20, 31, 32, 35, 36, 41, 43, 47, 60, 69, 78, 81, 98, 100. 1968. (Mniaceae)

[*Plagiomnium affine* (Bland. ex Funck) T. Kop. (*Mnium affine*, Porter 1935) = *Mnium affine* Bland. ex Funck]

Excluded from the North American flora by Anderson et al. (1990). Not reported for the flora of North America in FNA (FNA, Vol. 28, 2014). Wyoming: Yellowstone Natl Park (*1521*) (Roell 1893).



Courtesy FNA Association, FNA 28, 2014

Plagiomnium ciliare (Müll. Hal.) T. Kop.., Ann. Bot. Fenn. 5: 146. 1968.
Mnium affine var. *ciliare* Müll. Hal., Syn. Musc. Frond. 1: 159. 1848, based on *Bryum ciliare Grev.*, Ann. Lyceum Nat. Hist. New York 1: 273, plate 23 (upper left). 1825, not Dickson 1801.
Mnium ciliare (Müll. Hall.) Schimp.
Plagiomnium ciliare (Müll. Hall.) T. Kop.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014).

Albany Co.: Antelope Basin, on wet banks of the stream, *Nelson 7500,* Plants of Wyoming exs. det. Holz. (female plants) (RM). Carbon Co.: 8500 ft, *Porter & Porter 9714* (female plants) (RM).

The leaf cells are thick walled and porose, the leaves long decurrent on fertile stems, "not or slightly decurrent on sterile stems," Lawton 1971).

Plagiomnium cuspidatum (Hedw.) T. Kop.., Ann. Bot. Fenn. 5: 146. 1968.
Mnium cuspidatum Hedw., Sp. Musc. Frond. 192, plate 45, figs. 5–8. 1801.
Mnium cuspidatum var. *tenellum* Kindb. in Macoun & Kindb.

Wyoming (FNA, Vol. 28, 2014). Rogers Canyon, Albany Co. (*Porter 768a*); Little Goose Creek, Sheridan Co. (*Nelson 2366* & *2376*), Porter (1935). (As *Plagiomnium cuspidatum* (Hedw.) T. Kop.) Teton Co., Spence (1985). (As *Mnium cuspidatum* var. *tenellum* Kindb.) Laramie Mts., Albany County, *Nelson 4308*, Porter (1935).

Albany Co. (Laramie Hills), *Nelson 1898, 4308* (RM); 6 Aug 1934, *Porter s.n.* (RM). Crook Co.: Devil's Tower Natl Monument; 4050 ft, *1698* (RM). Park Co.: 7500 ft, *Hermann 20046* (RM).

Plagiomnium drummondii (P. Bruch & W.P. Schimper) T. Kop., Ann. Bot. Fenn. 5: 146. 1968.
Mnium drummondii P. Bruch & W.P. Schimper, London J. Bot. 2: 669. 1843 (as drummondi)
Plagiomnium drummondii (P. Bruch & W.P. Schimper) Kop.

Not noted for Wyoming in FNA (FNA, Vol. 28, 2014). Northern affinities (B.C. to Nova Scotia and S to Washington, Montana, Minn., Mich., New York, reported from Penn., W. Va., and Maryland (see Crum & Anderson 1981).

Sheridan Co.: Jul 16 1896, *Nelson 2366* (RM).

Plagiomnium ellipticum (Brid.) T. Kop.., Ann. Bot. Fenn. 8: 367. 1971.
Mnium ellipticum Brid., Muscol. Recent., suppl. 3: 53. 1817.
Mnium affine Bland. ex Funck, sensu lato, excluded from N. Amer. by Crum et al. (1973).
Mnium affine var. *rugicum* (Laur.) B.S.G.
Mnium affine var. *rugicum* (Laur.) P. Bruch & W.P. Schimper
Mnium rugicum Laur.
Plagiomnium rugicum (Laur.) Kop.

Wyoming (FNA, Vol. 28, 2014). In all states and provinces of the Pacific Northwest; Alaska, Yuk., Cal.; in the midW and in E. N. America from Labrador and Quebec to Penn.) (As *Mnium affine* Bland.) Albany, Big Horn Cos., Yellowstone Natl Park, Porter (1935). (As *Mnium affine* var. *rugicum* (Laur.) B.S.G. Park Co.: *Plagiomnium ellipticum* was reported growing with *Polytrichum juniperinum, Sarmentypnum exannulatum, S. sarmentosum and Sanionia nivalis* (Kosovich-Anderson & Weber 2011). Teton Co.: Camp Davis, Willow Creek 1942 Wehmeyer 3014 (MICH) (Koponen 1971). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *P. ellipticum*) Albany Co.: Medicine Bow Mts., 8000 ft, *Hermann 17723* (RM). Albany Co.: Centennial 1896, *Nelson 2670* (NY); 8000 ft, *Nelson 8819* (US, WTU) *Hermann 17723* (US); Antelope Basin, *Nelson 7500* (K, NY, US, WTU); Pole Creek, *Porter 1027* (WTU); NW base of Sheep Mtn along WY11, seep area (calcareous fen) with *Populus, Betula* and *Salix* dominant, *Buck 23225* (NY). (As *P. ellipticum* var. *rugicum*) Fremont Co.: Dubois, Togwotee Pass, 9000 ft, 1931, *Frye s.n.* (WTU); 7800 ft, *Hermann 25539* (RM). (As *Plagiomnium rugicum*). Johnson Co.: 5600–6000 ft, *Odasz 1263* (RM, BUF). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway; alpine bogs of east summit, east slope, head of Wyoming Creek, 3250 m, 19 Aug 1973, *Weber B–44258* (RM, COLO); wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, Aug 12 1990, *Elliott 1780* (BUF). Park Co.: T 54 N, 9600–9900 ft, *Hermann 22341* (RM). (As *Plagiomnium ellipticum* var. *rugicum)*: Sublette Co.: Gros Ventre Mts., 8500 ft, *Curtis s.n.* (NY). Sublette Co.: 7950 ft, *Hermann 25336* (RM); Bridger Wilderness, Wind River Range, ca. 1/4 mi SW of Barnes Lake, 9780 ft, 42°59'N, 109°36'W, pothole fen, 15 May 1989, *Andrus 7810,* variable teeth, blunt; thin transversely elongate cell walls (BING). Teton Co.: Grand Tetons Nat. Park, *Sharp & Sharp D3-b (*MICH); on US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* woodland, xeric but for stream bottoms, wooded stream, soggy debris, 6 Jul 1985, *Eckel 94082107* (BUF); Grand Tetons Nat. Park, *Sharp & Sharp D3-b* (MICH). Yellowstone Natl Park: *Roell 1521* (P); Snake River, *Nelson & Nelson 6426* (K, NY, US); Old Faithful, Firehole River, *Frye, s.n.* (CAN, WTU). (As *M. affine* var. *rugicum*) Yellowstone Natl Park: 6 Jul 1934, *Fry s.n.* (RM).

The erect, fertile stems are shorter than the plagiotropic, sterile elongate stems that can form extensive mats. The laminal and bordering cells are very thin, porose, not thickened at the corners. The leaves may have rather long, thin decurrencies due to the narrow and ellongate marginal cells extending down the stem. Mats are a rather sordid yellow-green, with yellowish stems and leaves, as opposed to the rustry-red mats of *Mnium arizonicum* (red stems with green leaves).

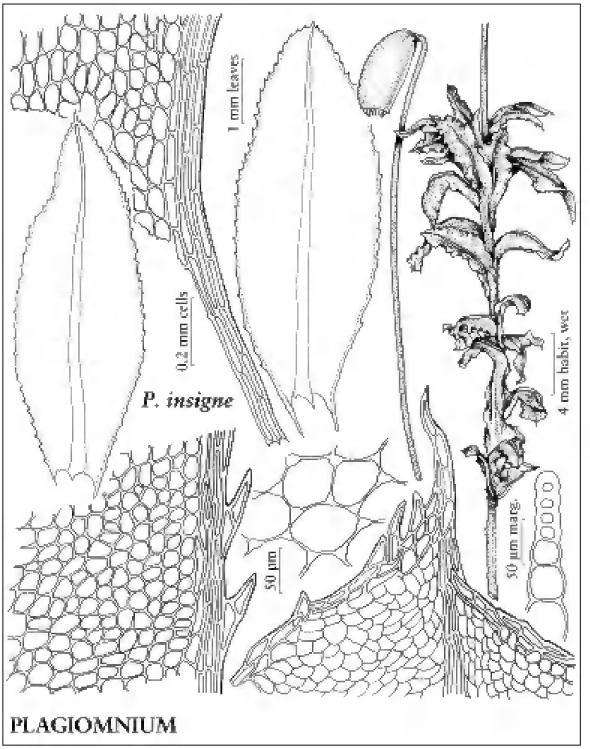
Both *Plagiomnium ellipticum* (Brid.) Kop. (= *Mnium rugicum* Laur.) and *P. rostratum* (Schrad.) Kop. overlap in characters. *P. ellipticum* has broader, more (transversely) elongate leaf cells, whereas *P. rostratum* has smaller and more isodiametric laminal cells. Both species may show no teeth on the margins. Ultimately, *P. ellipticum* grows in fens and *P. rostratum* "prefers calcareous rocks", and soil in woods. *Plagiomnium rostratum* is said to have "no decurrent leaf bases, or only very shortly decurrent leaves" which accounts for its frequent confusion with *P. ellipticum.*

Plagiomnium insigne (Mitt.) T. Kop.., Ann. Bot. Fenn. 5: 146. 1968.
Mnium insigne Mitt., Hooker's J. Bot. Kew Gard. Misc. 8: 230. 1856.
Plagiomnium insigne (Mitt.) T. Kop.

Wyoming (FNA, Vol. 28, 2014). The species is more common along the West Coast.

Plagiomnium medium (P. Bruch & W.P. Schimper) T. Kop., Ann. Bot. Fenn. 5: 146. 1968.
Mnium medium P. Bruch & W.P. Schimper, Bryol. Europ. 4: 196, plate 398. 1838.
Plagiomnium medium subsp. *curvatulum* (Lindb.) T. Kop.
Plagiomnium. medium var. *curvatulum* (Lindb.) H.A. Crum & L.E. Anderson

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Plagiomnium medium (P. Bruch & W.P. Schimper) T. Kop., Ann. Bot. Fenn. 5: 146. 1968.
Mnium medium P. Bruch & W.P. Schimper, Bryol. Europ. 4: 196, plate 398. 1838.
Plagiomnium medium subsp. *curvatulum* (Lindb.) T. Kop.
Plagiomnium. medium var. *curvatulum* (Lindb.) H.A. Crum & L.E. Anderson

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sheridan Co.: "Floating on water and on logs and branches in slow flowing water," Bighorn Natl Forest, T57N, R89W, Section 28, 25 Jun 1992, *McKee 92–049*, c.fr., dehisced empty (BUF, RM).

Plagiomnium rostratum (Schrader) T. Kop.., Ann. Bot. Fenn. 5: 147. 1968.
Mnium rostratum Schrader, Bot. Zeitung (Regensburg) 1: 79. 1802.
Bryum longirostrum (Brid.) Brid.
Hypnum rostratum (Schrad.) Web. & Mohr
Mnium longirostrum Brid.
Mnium rostratum Schrad.
Plagiomnium rostratum (Schrad.) T. Kop.

Not noted for Wyoming in FNA Vol. 28, 2014. In all states and provinces of the Pacific Northwest; in the mid West, and in eastern North America from New Jersey to South Carolina (Crum & Anderson 1981: 599). (As *Mnium rostratum* Schrad.) Albany, Carbon, Fremont cos., Yellowstone Natl Park, Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: wet shaded bank of stream in spruce grove, 1 1/4 S of Brooklyn Lake, Medicine Bow Mts., 10,000 ft, 9 mi W of Centennial, *Hermann 17700* (WTU). Hermann identified this specimen as *Mnium rugicum* "form with entire leaf-margins", a determination with which I am inclined to agree. However, T. Koponen determined this specimen as *Mnium rostratum*, and I defer to his experience. The latter, however, is characteristic of more mesic sites, growing on calcareous rocks—see discussion on *Plagiomnium ellipticum* above. Johnson Co.: T52N, R84W, Sec. 25, 5600–6000 ft, *Odasz 1262,* c.fr., rostrate (RM)*;* T52N, R84W Sec. 25, 5600–6000 ft, *Odasz 1260*, c.fr. (RM).

Plagiomnium ellipticum does not have the collenchymatous cell walls of *P. rostratum*, whose cell walls are thicker and not porose.

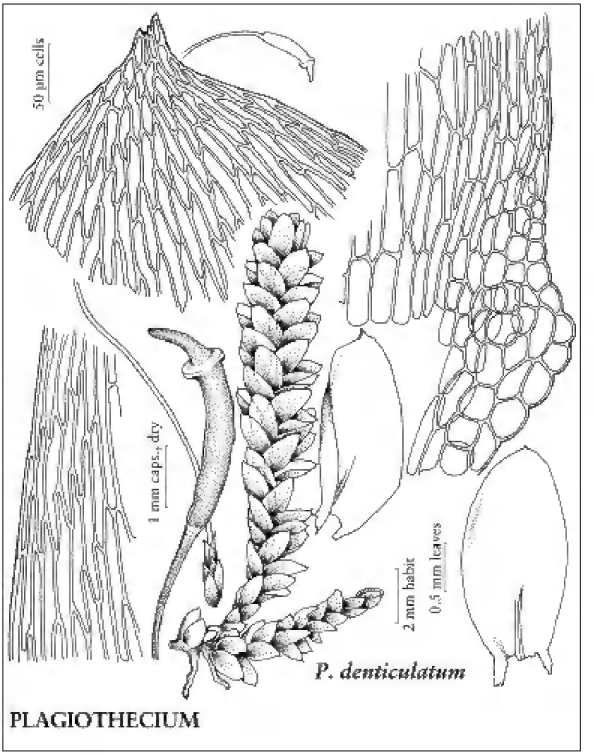
PLAGIOTHECIUM Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 179, plates 494–506. 1851. (Plagiotheciaceae)
Stereodon sect. Plagiothecium (Schimper) Mitt.

[*Plagiothecium cavifolium* (Brid.) Iwats. Excluded, wrong det.]
Hypnum sullivantiae (Sull.) Sull. & Lesq.
Plagiothecium fallax Card. & Thér.
Plagiothecium roseanum B.S.G.
Plagiothecium sullivantiae Sull. in Gray

Brooklyn Lake, Albany County (*Nelson 5242*), Porter (1935) (as *Plagiothecium roseanum* (Hampe) Bruch & Schimp. (has been reidentified (RM) as *Isopterygiopsis pulchella*, q.v.)

Plagiothecium denticulatum (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 190. 1851.
Hypnum denticulatum Hedw., Sp. Musc. Frond., 237. 1801.
Hypnum donnianum Smith
Hypnum obtusifolium (Turner) Brid.
Plagiothecium denticulatum var. *bullulae* Grout
Plagiothecium ruthei Limpr.
Plagiothecium sandbergii Ren. & Card.
Plagiothecium sylvaticum var. *squarrosum* Kindb.

Wyoming (FNA, Vol. 28, 2014). Albany County and Teton County, Porter (1935). Albany, Carbon, Teton Cos., Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

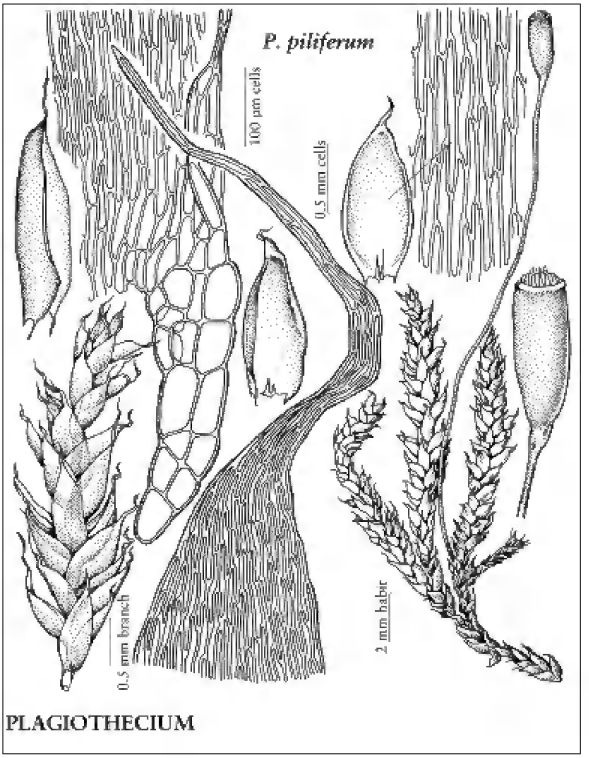


Courtesy FNA Association, FNA 28, 2014

Albany Co.: 10,000 ft,Medicine Bow Mts., *Hermann 17763* (RM); Centennial, Lake Marie, alt, 10,000 ft, 25 Jun 1931, *Frye & Ireland s.n* (WTU). Carbon Co.: on rotten wood and soil, lake shore, Stamp Mill Lake, 10,000 ft, 28 Aug 1935, *Porter 2083*, c.fr. (WTU). Sublette Co.: Wind River site, Bridger Wilderness, Wind River Range, Barnes Lake, ca. 9747 ft, 42°59'N, 109°36'W, Pothole fen, 15 May 1989, *Andrus 7809,* in packet of *Brachythecium oedipodium* (BING). Teton Co.: 7000 ft, *Hermann 25565* (RM, WTU). Yellowstone Natl Park: Crescent Hill, 17 Aug 1953, *Lawton 1850*, c.fr., (WTU).

This is a large, flabby, delicate plant with large, broad decurrencies of hyaline, rounded, thin-walled cells. The leaf cells are long- rhomboidal, versus linear-flexuose as in *P. laetum* (cf. Crum & Anderson 1981: 1096). Care must be taken to remove the alar cells with their distinctive circular cells, which may be fragile and remain behind on the stem on dissection, in which case one might tend to the erroneous confusion with *P. laetum*.

Plagiothecium piliferum (Sw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 186. 1851.
Leskea pilifera Sw. in c. J. Hartman, Handb. Skand. Fl., 419. 1820.
Dolichotheca pilifera (Sw.) Podp.
Isopterygium piliferum (Sw.) Loeske
Plagiotheciella pilifera (Sw.) Broth.



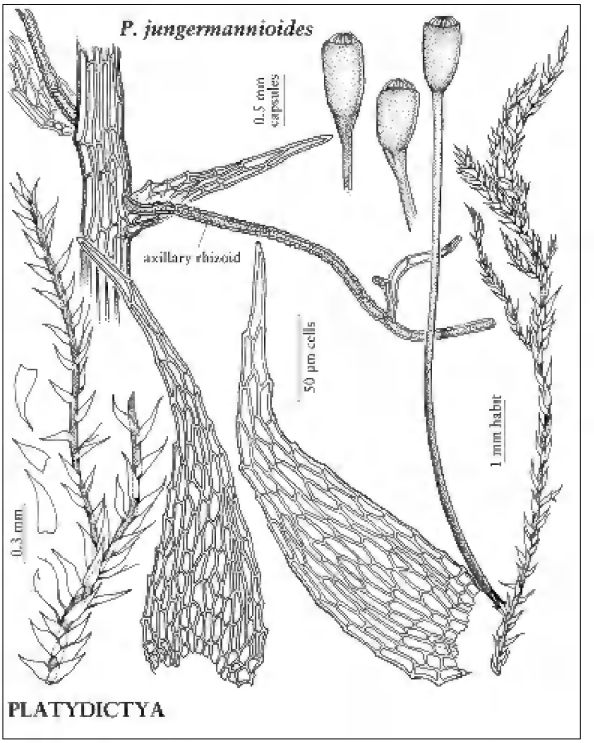
Courtesy FNA Association, FNA 28, 2014

Not noted for Wyoming in FNA (FNA, Vol. 28, 2014). Teton Co., Spence (1985).

[*Platydictya confervoides* (Brid.) H.A. Crum, Michigan Bot. 3: 60. 1964, excluded]
Amblystegiella confervoides (Brid.) Loeske
Amblystegium pseudoconfervoides Kindb.
Hypnum confervoides Brid.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014). (As *Amblystegiella confervoides* (Brid.) Loeske.) "On limestone rocks, Rogers Canyon, Albany County (Porter 950). This is a somewhat doubtful determination" (Porter 1935).

This species appears to be native to eastern North America, with occasional specimens from Alaska and the Yukon (FNA, Vol. 28, 2014))



Courtesy FNA Association, FNA 28, 2014

PLATYDICTYA Berkeley, Handb. Brit. Mosses, 145. 1863. (Amblystegiaceae)
Serpoleskea (Hampe) Loeske

Platydictya jungermannioides (Brid.) H.A. Crum, Michigan Bot. 3: 60. 1964.
Hypnum jungermannioides Brid., Muscol. Recent., suppl. 2: 255. 1812.
Amblystegiella sprucei (Spruce) Loeske
Leskea sprucei Brush ex Spruce

(As *Amblystegiella sprucei* (Bruch) Loeske) Mammoth, Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985).

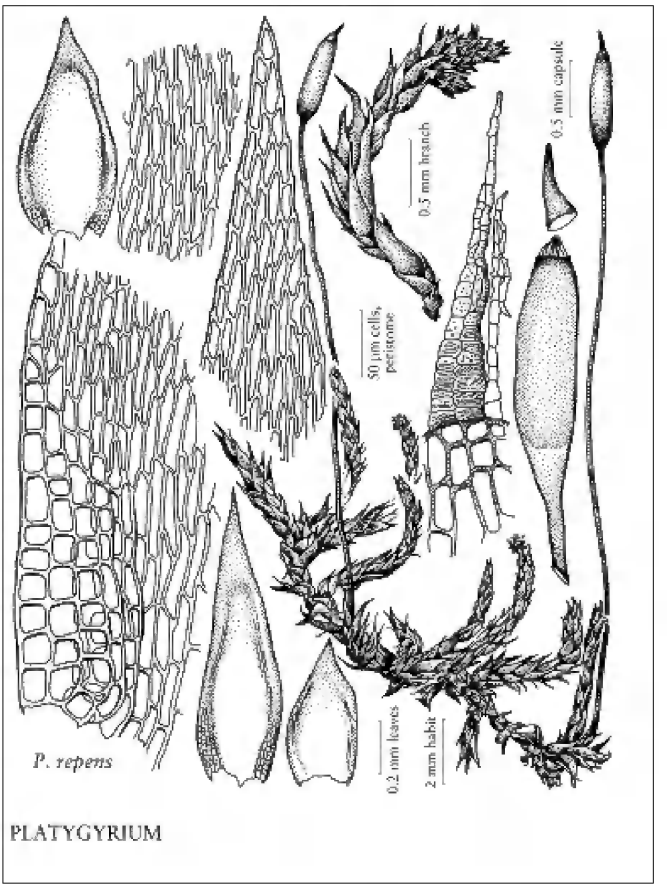
Albany Co.: Medicine Bow Mountains, Barber Lake Picnic area, 2.5 air mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest, at base of *Populus tremuloides*, 7 Jun 1993, *Miller 10,253* (NYS). Sublette Co.: Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, wooded spruce bank, sandstone rocks, lush herbage, N slope, Hoback River valley, shaded sandstone rock, 5 Jul 1985, *Eckel 9612510,* with *Drepanocladus uncinatus* (BUF). Teton Co.: 7000 ft, *Hermann 25572* (RM); *Pinus-Pseudotsuga*-forests, primitive rocks about 2260 m, on soil, 7 Aug 1981, *Duell 2245* (NY). Teton Co., on US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* wood-land, xeric but for stream bottoms, wooded stream, soggy debris, 6 Jul 1985, *Eckel 94082112,* c.fr., with *Brachythecium salebrosum, Campylium*

chrysophyllum, Cratoneuron filicinum, Distichium capillaceum, Mnium marginatum, Plagiomnium ellipticum, Drepanocladus aduncus, Aulacomnium palustre (BUF).

PLATYGYRIUM Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 95, plate 458. 1851, name conserved. (Hypnaceae)

Platygyrium repens (Brid.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 98. 1851.
Pterigynandrum repens Brid., Muscol. Recent., suppl. 1: 131. 1806.
Platygyrium orthoclados Kindb.
Platygyrium repens var. *ascendens* (Schwägr.) Grout
Platygyrium repens var. *orthoclados* Kindb.

Wyoming (FNA, Vol. 28, 2014).



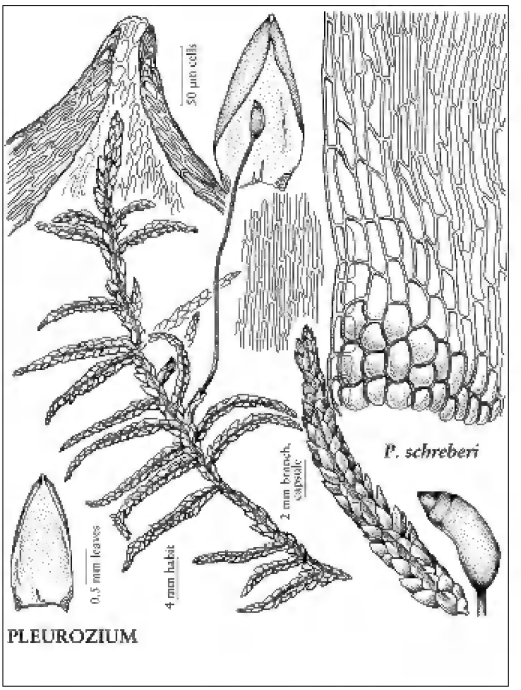
Courtesy FNA Association, FNA 28, 2014

PLEUROZIUM (Sullivant) Mitt., J. Linn. Soc., Bot. 12: 537. 1869, name conserved (Hylocomiaceae)
Hypnum sect. Pleurozium Sull. in A. Gray, Manual ed. 2, 668. 1856.

Pleurozium schreberi (Willd. ex Brid.) Mitt., J. Linn. Soc., Bot. 12: 537. 1869.
Hypnum schreberi Willd. ex Brid., Muscol. Recent. 2(2): 88. 1801.
Calliergon schreberi (Brid.) Mitt.
Calliergonella schreberi (Brid.) Grout
Calliergonella schreberi var. *tananae* (Grout) Grout
Pleurozium schreberi var. *tananae* (Grout) Wijk & Margadant

Wyoming (FNA, Vol. 28, 2014). All states and provinces of the Pacific Northwest. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Yellowstone Natl Park: wet soil, Norris Geyser Basin, Aug 14 1925, *Frye s.n.* (WTU); near Giant Paint Pot, 16 *Aug* 1925 *Frye s.n.* (WTU).



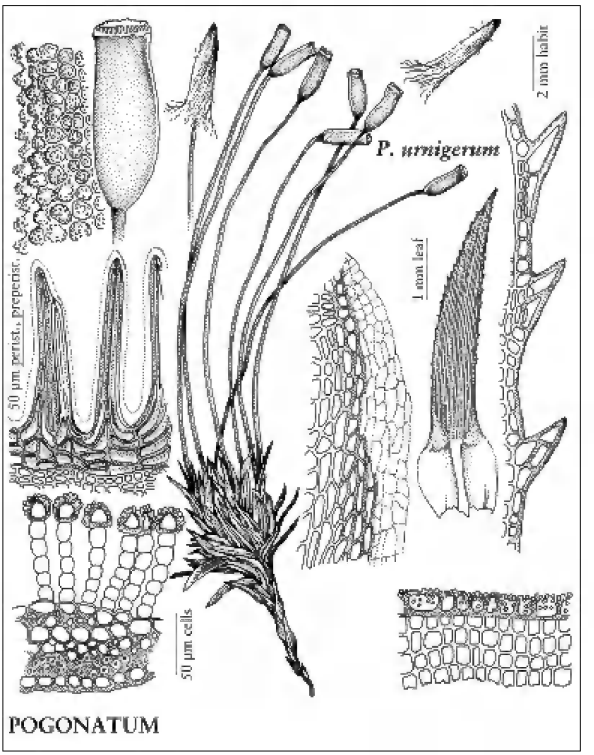
Courtesy FNA Association, FNA 28, 2014

POGONATUM P.-Beauv., Mag. Encycl. 5: 329. 1804. (Polytrichaceae)

Pogonatum urnigerum (Hedw.) P.-Beauv., Prodr. Aethéogam., 84. 1805.
Polytrichum urnigerum Hedw., Sp. Musc. Frond., 100, plate 22, figs. 5–7. 1801.

Not reported for Wyoming in FNA Vol. 27, 2007. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, Shoshone Natl Forest, Little Bear Creek, ca. 100 m W of the Natl Forest Rd #151 dead end, north-facing granite cliff ledge, on sandy substrate, forming an admixture with *Paraleucobryum enerve,* 44°56.480–490' N, 109°30.980–990'W, ca. 9700 ft (2950 m), 14 Aug 2008, *Kosovich-Anderson 2712* (MO, RM) (also in Kosovich-Anderson 2011b).



Courtesy FNA Association, FNA 27, 2007

POHLIA Hedw., Sp. Musc. Frond., 171. 1801. (Mielichhoferiaceae)

Pohlia andalusica (Höhnel) Broth. in H. G. A. Engler and K. Prantl, Nat. Pflanzenfam. 218 (I,3): 551. 1903.

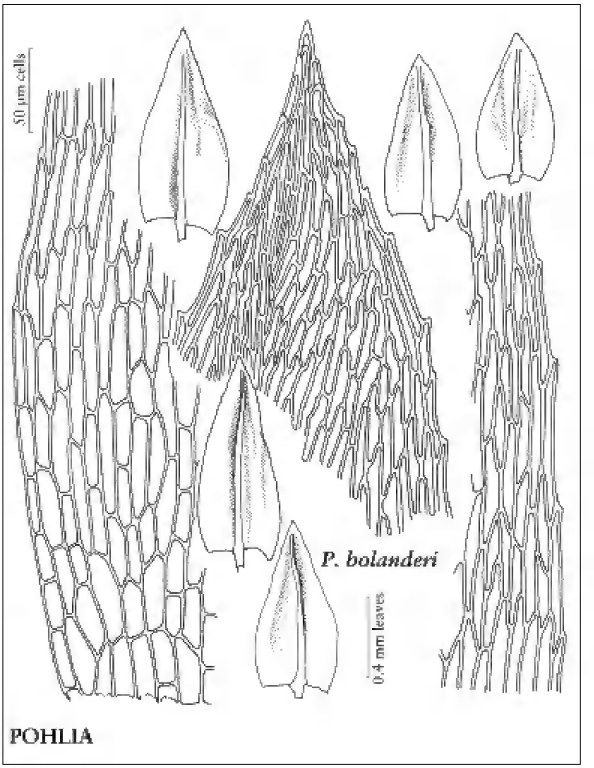
Webera andalusica Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Wien, Math.-Naturwiss. Cl., Abt. 1, 104: 326. 1895.

Pohlia annotina var. *glareola* (Ruthe & Grebe in Grebe) Broth.

Pohlia glareola (Ruthe & Grebe in Grebe.) Broth. in Engl. & Prantl.

Pohlia hercynica Warnst. in Bauer.

Pohlia rothii var. *compacta* Ruthe & Loeske in Loeske



Courtesy FNA Association, FNA 28, 2014

Wyoming (FNA, Vol. 28, 2014). Teton Co., Grand Teton Natl Park, 7 km W of Teton Park Rd. on Signal Mtn. Summit Rd., *Shaw 2704* (ALTA) (Shaw 19981a: 43).

[*Pohlia annotina* (Hedw.) Lindb. var. *annotina: see Pohlia camptotrachela* (Ren. & Card.) Broth. in H G.A. Engler and K. Prant.]

Pohlia annotina is to be looked for in Wyoming as "*Pohlia annotina* is the most widespread and common gemmiferous species in eastern North America and along the Pacific coast" (Shaw, FNA 28, 2014). Not yet reported for Wyoming.

Pohlia bolanderi (Lesq.) Broth. in H. G. A. Engler and K. Prantl, Nat. Pflanzenfam. 218(I,3): 548. 1903.
Bryum bolanderi Lesq., Mem. Calif. Acad. Sci. 1: 22. 1868.
Pohlia bolanderi var. *seriata* A.J. Shaw

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Pohlia bolanderi* var. *seriata*) Albany Co.: peaty vertical bank of trail along Lewis Lake, alt. 10,800 ft, Medicine Bow Mts., ca. 11 mi W of Centennial, 3 Aug 1962, *Hermann 17716* (RM). Sublette Co.: 11,200 ft, alpine moist area, *Rolston 85122* (CSU); under spruce in moist forest, 10,055 ft, *Rolston 86023* (CSU).

Pohlia camptotrachela (Ren. & Card.) Broth. in H. G. A. Engler and K. Prantl, Nat. Pflanzenfam. 218(I,3): 552. 1903.
Webera camptotrachela Ren. & Card., Bot. Gaz. 13: 199, plate 16. 1888.
Bryum camptotrachelum (Ren. & Card.) Paris
Bryum nutans ssp. *camptotrachelum* (Ren. & Card.) Kindb.

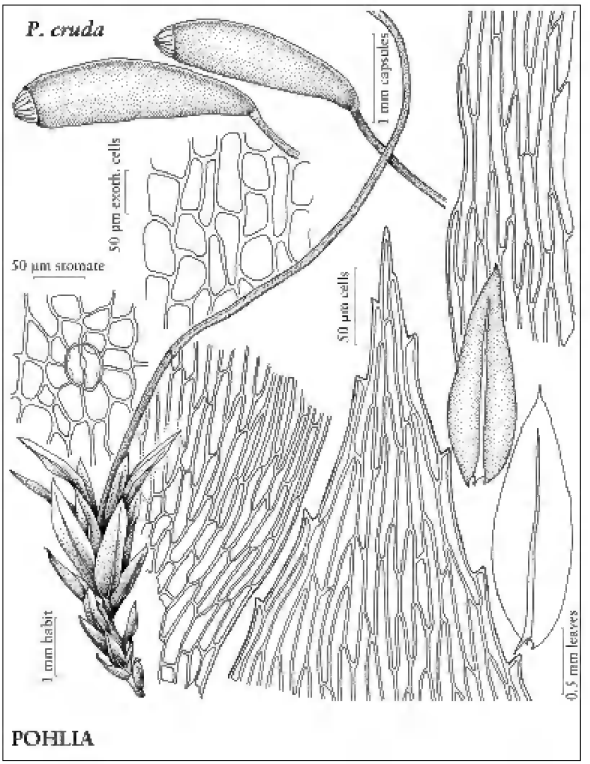
Wyoming (Vol. 28, 2014). Teton Co.: Bradley Lake Trail, 7000 ft, Shaw 2692 (ALTA) (Shaw 1981a: 72).

Pohlia cruda (Hedw.) Lindb., Musc. Scand. 18. 1879.
Mnium crudum Hedw., Sp. Musc. Frond. 189. 1801.
Bryum crudum (Hedw.) Turn.
Webera cruda (Hedw.) Fuernr.
Webera macroapiculata Müll. Hall. & Kindb. in Macoun

Wyoming: Yellowstone Natl Park, c.fr., (*1514*), Upper Falls (*1500*) (Roell 1893).
In all states and provinces of the Pacific Northwest; Alaska, Cal., Ariz., Col; Minnes., Iowa, Ont.; Greenland, Quebec, New Brun., New Eng. Pennsyl. Albany, Carbon cos., Porter (1935). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming (Spence 1981). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: *Eckel 871108* (BUF); woodland bog, Medicine Bow Mts., published label Plants of Wyoming, 30 Jul 1900, *Nelson s.n.* det. Holz., c.fr., deoperculate (RM); soil on wet, rocky edge of stream in aspens, 8590 ft, Laramie, 7 Jun 1972, *Hermann 24867*, young fruit (RM). Carbon Co.: moss-covered peaty bank of Trail Creek W of Sand Lake, 9000 ft, Medicine Bow Mts., 41/2 SW Morgan, c.fr., 6 Aug 1962, *Hermann 17805* (RM); southeastern county, Medicine Bow Mts., on the Sand Lake road at Trail Creek, 9200 ft, Spruce-Fir zone, soil in forest, common, 11 Aug 1964, *Porter 9700*, c.fr., operculate (RM). Johnson Co.: Big Horn Mtns., in mixed conifer forest, 9400 ft, Aug 17 1980, *Nelson & Fonken 7264*, c.fr., operculate (BUF, RM). Park Co.: *Hermann 25568* (RM). Sheridan Co.: mineral soil on limestone, Big Horn Natl Forest, with *Mnium blyttii*, 16 Jun 1992, *McKee 92–023,* c.fr., indehiscent, ecalyptrate (BUF, RM). Sublette Co.: moist soil on rock under ledge on W shore of Lower Green River Lake, 7950, Wind River Range, 50 mi N of Pinedale, *Hermann 25328* (RM); Bridger Wilderness, Wind River Range Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at south end of lake with *Polytrichastrum alpinum*, *Andrus 7791a* (BING). Teton Co.: peaty soil in wet ditch along Hidden Falls Trail, NW shore of Jenny Lake, 7000 ft,Teton Range, Grand Teton Natl. Centennial Valley, 17 Aug 1896, *Nelson 2657,* c.fr. (RM).

This species has large flat leaves distant on the bright red stem, below leaves are small and often hyaline. The stem is usually a bright or dark red compared to the glacine green yellow-white to blue-green (glaucous) leaves. Leaves are not decurrent. Leaf margins plane (except in perichaetial leaves), no border, toothed (cf. *Bryum wiegelii*, with strongly decurrent leaf bases, distant on stem, bordered). In fruiting or female plants the perichaetial leaves are conspicuously longer than the subtending leaves, quite thinner and in some contrast with the stem leaves.

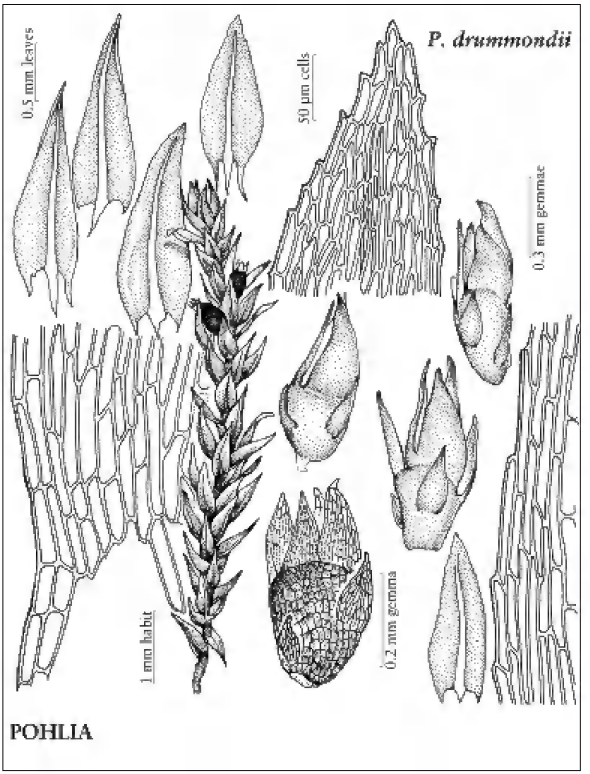


Courtesy FNA Association, FNA 28, 2014

Pohlia drummondii (Müll. Hal.) A. L. Andrews in A. J. Grout, Moss Fl. N. Amer. 2: 196. 1935.
Bryum drummondii Müll. Hal., Bot. Zeitung (Berlin) 20: 328. 1862 (as drummonii)
Pohlia commutata Lindb.

Wyoming (FNA, Vol. 28, 2014). Teton Co., banks of Bradley Lake Trail, *Shaw 2695* ALTA, Shaw (1981). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, Spence (1981). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: (in specimen of *Desmatodon latifolius*) along stream near Bear Tooth Lodge at 9000 ft, 20 Aug 1953, *Lawton 1933,* c.fr., red stem throughout, material fertile and fruiting (WTU).



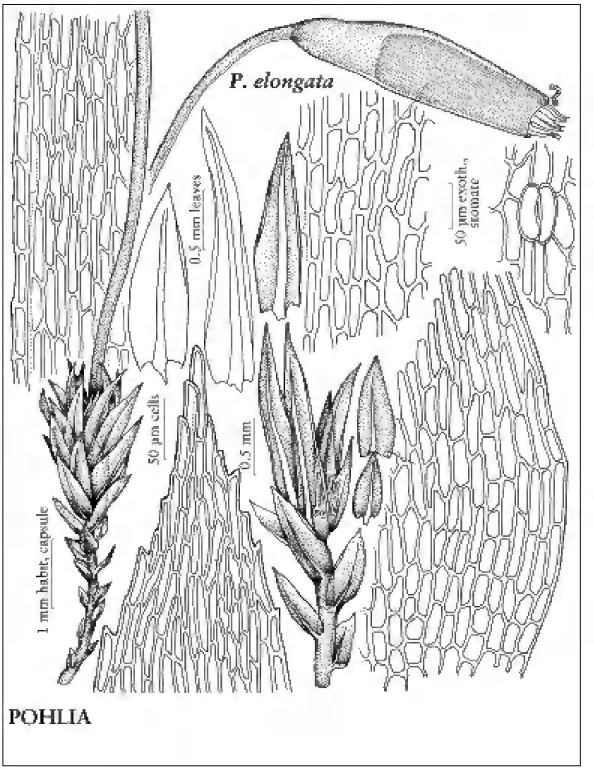
Courtesy FNA Association, FNA 28, 2014

Pohlia elongata Hedw., Sp. Musc. Frond., 171. 1801.
Pohlia acuminata Hoppe & Hornschuch
Pohlia elongata var. *greenii* (Brid.) A. J. Shaw
Pohlia polymorpha Hoppe & Hornschuch

Not reported for Wyoming by FNA (FNA, Vol. 28, 2014). The species is widespread in North America but not common (Shaw in FNA Vol. 28, 2014). Albany Co. (*Nelson 1723*, in part), Porter (1935).

[*Pohlia lescuriana* (Sullivant) Ochi, J. Fac. Educ. Tottori Univ., Nat. Sci. 19: 31. 1968, excluded.]

Not reported for Wyoming; "*Pohlia lescuriana* is an inconspicuous woodland species in eastern North America" (Shaw, FNA Vol. 28, 2014). Yellowstone Lake, Yellowstone Natl Park (*Smiy*), Porter (1935) (probably a misidentification).)



Courtesy FNA Association, FNA 28, 2014

Pohlia longicolla (Hedw.) Lindb., Musc. Scand. 18. 1879 (as longicollis)
Webera longicolla Hedw., Sp. Musc. Frond., 169, plate 41, figs. 1–5. 1801.

Wyoming , a species that is "relatively rare in North America" (Shaw in FNA, Vol. 28, 2014). (As *Pohlia longicollis* (Sw.) Lindb.): Wyoming: Yellowstone Natl Park, Upper Fall, 7000 ft, (*1498–99*) (Roell 1893).

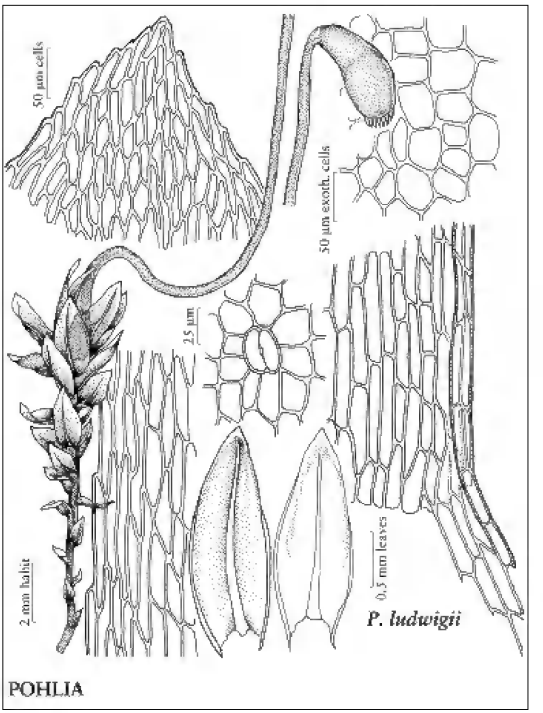
Big Horn Co.: Big Horn Mtns; east end of Battle Park, ca. 9 air mi SW of Cloud Peak, ca. 20 mi ESE of Basin, sandstone ledges, 9100 ft, 19 Aug 1980, *Nelson & Fonken 7354*, c.fr., deoperculated (RM, Ithaca College, see Eckel 1992.)

Pohlia ludwigii (Sprengel ex Schwägr.) Broth., Acta Soc. Sci. Fenn. 19(12): 27. 1892.
Bryum ludwigii Sprengel ex Schwägr., Sp. Musc. Frond. Suppl. 1(2): 95, plate 68 (right). 1816.
Bryum bigelovii Sull.
Mniobryum ludwigii (Schwaegr.) Loeske
Webera ludwigii (Schwaegr.) Schimp.

Not reported from Wyoming by FNA (FNA, Vol. 28, 2014). Wyoming; Colo. reported from Calif.; Brooklyn Lake, Albany Co. (*Nelson 7883*), Porter (1937). Halleck Canyon, Albany County (*Nelson 7442*), Porter (1935).

Albany Co.: Telephone Mines, *Nelson 7883* (RM). Fremont Co.: 8600 ft, *Hermann 25303* (RM).

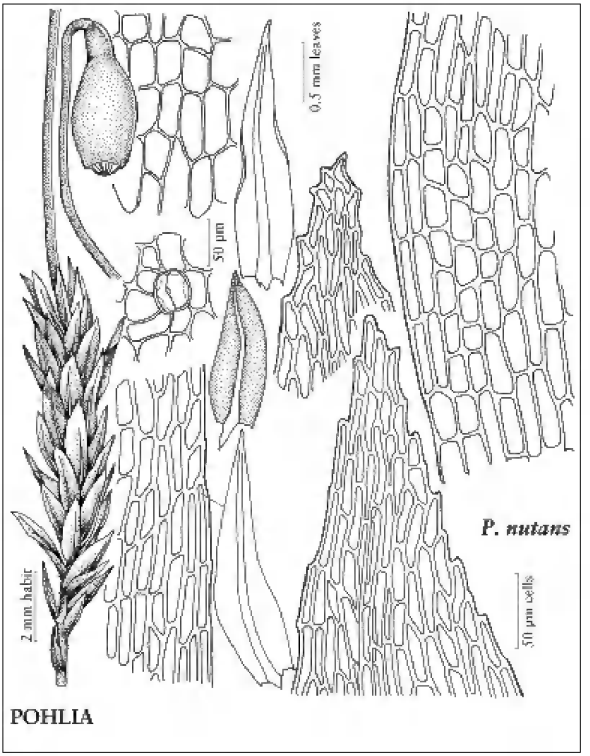
Pohlia ludwigii is the largest species of the genus and is closely related and similar to *P. drummondii*, which has propagula. Both have recurved leaf margins in the upper part of the leaf, whereas *P. wahlenbergii* is plane. (? var. *microphylla* Kindb. Not in Anderson et al. 1990 checklist or in Index Muscorum).



Courtesy FNA Association, FNA 28, 2014

Pohlia nutans (Hedw.) Lindb., Musc. Scand. 18. 1879.
Webera nutans Hedw., Sp. Musc. Frond., 168. 1801.
Pohlia sphagnicola (P. Bruch & W.P. Schimper) Lindb. & Arnell

Wyoming (FNA, Vol. 28, 2014). Wyoming: Yellowstone Natl Park, c.fr., (*1502, 1502, 1504*) (Roell 1893). In all states and provinces of the Pacific Northwest; Alska, Cal., Ariz., Nev., Colo.; in the mid W and eastern N. America from Nova Scotia to N.C. "Common throughout most of the State." Albany, Big Horn, Carbon, Crook cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Campbell Co., Medina (1994). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

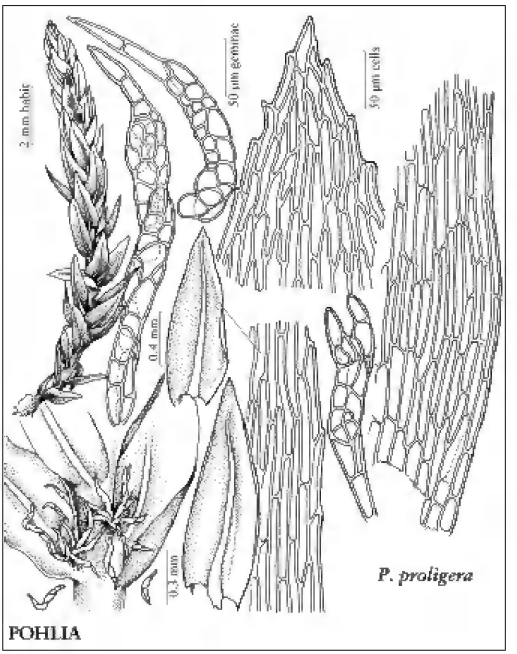
Albany Co.: 8000 ft, *Schriever 8* (RM). Big Horn Co.: *Hartman & Odasz 8800* (RM); *Nelson 4941*. Fremont Co.: on US 26 & US 287, 5 mi E of Togwotee Pass, S slope, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis, Pinus contorta*, xeric, 6 Jul 1985, *Eckel 94081606,* c.fr. (BUF). Johnson Co.: Big Horn Mts., on and around rotten log in mixed conifer forest, 9400 ft, 17 Aug 1980, *Nelson & Fonken 7262*, c.fr., operculate (BUF, RM). Lincoln Co.: 7800 ft, *Goodman 5135* (RM). Park Co.: Absaroka Range, by mine effluent flow in soil wetted by the copper enriched water, *Kastning-Culp 3101* (BUF, RM). Sheridan Co.: Big Horn Mtns., openings in valley and on slopes, 8800 ft, 23 Jun 1979, *Hartman & Odasz 9247* (BUF, RM). Sublette Co.: in montane lake, 10,190 ft, *Rolston 85126* (CSU); Bridger Wilderness, Wind River Range, ca. 1/4 mi SW of Barnes Lake, 9780 ft, 42°59'N, 109°36'W, pothole fen, 15 May 1989, *Andrus 7808* (BING); Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, wooded spruce bank, rocks, lush herbage, N slope, Hoback River valley, punky log, with *Saonia uncinata, Brachythecium salebrosum, Eurrhynchium,* 5 Jul 1985, *Eckel 9612513* (BUF, RM). Teton Co.: 7000 ft, *Hermann 25573* (RM). Yellowstone Natl Park: *Nelson & Nelson 5846* (RM); Hayden Forest, head of Soldier Creek, 9500 ft, common on sour soils, abundant locally, 11 Sep 1923, *Rose 220 1/2*, c.fr., dehisced (RM); La Plata Mines, 25 Aug 1898, *Nelson 5175*, deoperculate fruit (RM).

When dissecting for sexual structures, the antheridia on the fruiting stem are usually very evident in this species (they are conspicuously large)—they will not appear so in fruiting stems of the other common *Pohlia, P. wahlenbergii*, or the rare *P. drummondii*, because these are dioicous.

Pohlia obtusifolia (Villars ex Brid.) L.F. Koch, Leafl. W. Bot. 6: 20. 1950.
Bryum obtusifolium Villars ex Brid., Muscol. Recent. 2(3): 52. 1803.
Bryum cucullatum (Schwägr.) Bruch ex Hochstetter
Pohlia cucullata (Schwägr.) Bruch ex Hochstetter
Webera cucullata (Schwaegr.) Schimp.

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Fremont Co.: Gannett Peak area, Wind River Range, base of Gannett Glacier, 12,000 ft, wet places near a creek, 5 Aug 1963 *Jozwik 460*, young fruit (RM). Park Co.: 3200 m, rills and snowbeds, *Weber B–44319* (COLO, RM).



Courtesy FNA Association, FNA 28, 2014

Pohlia proligera (Kindb.) Lindb. ex Arnell, Bot. Not. 1894: 54. 1894.
Webera proligera Kindb., Forh. Vidensk.-Selsk. Kristiania 1888(6): 30. 1888.

Not reported from Wyoming by FNA although it "is a relatively common species in boreal and high-montane habitats" (Shaw, FNA, Vol. 28, 2014). B.C., Wash., Idaho. Wyoming; Alask, Yuk., Nev.; Minn.; Mich.; Greenland, Quebec. Teton Co., Spence (1985).

Albany Co.: 7800 ft, *Hermann 25929* (RM). Carbon Co.: Sierra Madre Range, on Bridger Peak, 10,400–11,004 ft, sub-alpine, *Kastning-Culp 1063* (BUF).

The linear, twisted, vermicular or worm-like gemmae in the axils of especially the upper leaves of this species have either one or two erect unicellular extensions (leaf primordia) at the apex. Usually one of these apical primordial is longer than the other. These gemmae are distinguished from those of the eastern and western species, *P. annotina*, with similar gemmae but which have 2–5 leaf primordial at their apices. The base of the leaf itself is not decurrent but the majority of leaves are transversely rather straight across. However strips of the stem-cells often may come away on the margins or across the base of the leaf and give some leaves decurrencies.

Pohlia tundrae A. J. Shaw, Bryologist 84: 65, figs. 1–10. 1981.

Wyoming (FNA, Vol. 28, 2014). "... all reports of *P. annotina* var. *decipiens* from the mountains of Utah and Colorado are referable to *P. tundrae*" (Shaw 1981). Teton Co., Spence (1985). "Teton Co., 7 km W of Teton Park Rd. on Signal Mtn. Summit Rd., *Shaw 2709* (ALTA)" (in Shaw 1981).

Carbon Co.: (*P. annotina* var. *decipiens* Loeske) Sierra Madre Mtns, Haggarty Creek just below Ferris-Haggarty mine, 9520 ft, wet soil by streamside, *Kastning-Culp 3082* (BUF, RM). Teton Co.: (*P. annotina* var. *decipiens*) Togwotee Pass, 9650 ft, *Hermann 25542* (RM).

Pohlia wahlenbergii (F. Weber & D. Mohr) A. L. Andrews in A. J. Grout, Moss Fl. N. Amer. 2. 203. 1935.

Hypnum wahlenbergii F. Weber & D. Mohr, Bot. Taschenbuch, 280, 475. 1807.
Bryum wahlenbergii (Web.& Mohr) Schwaegr.
Mniobryum albicans (Wahlenb.) Limpr.
Mniobryum wahlenbergii (Web. & Mohr) Jenn.
Mnium albicans Wahlenb.
Pohlia albicans (Wahlenb.) Lindb.
Webera albicans (Wahlenb.) Schimp.

Wyoming (FNA, Vol. 28, 2014). In all states and prov of the Pacific Northwest. Alaska, Ariz, Colo.; widespread in the mid. W and in eastern N. Amer. "Across the southern part of the State," Albany, Carbon, Sweetwater, Uinta cos., Porter (1935). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: densely shaded bertical bank of streamlet under thicket in meadow, 10,000 ft, Medicine Bow Mtns., 9 mi W of Centennial, *Hermann 17727* (RM); Centennial Hills, 9 Jun 1895, *Nelson 1285*, c. young fr. (RM); northwest base of Sheep Mtn. along WY Rte. 11, ca. 4 mi due ESE of Centennial, 7,700–7,800 ft, fen with low forest of *Populus, Betula, Salix,* in shallow water, a "hanging bog" on steep hillside, open area of bog, 7 Jun 1993, *Reese 18180* (LAF, BUF, RM). Carbon Co.: Sierra Madre Mtns, Haggarty Creek, 8440 ft, moist soil by creek, *Kastning-Culp 3038* (BUF, RM). Carbon Co.: Battle Lake, *Nelson 4180,* leaves long-decurrent (RM). Sublette Co.: wet area in alpine, 10,595 ft, *Rolston 85102* (CSU). Sweetwater Co.: North Vermillion Creek, *Nelson 3576* (RM). Teton Co.: 7000 ft, *Hermann 25564* (RM); Hat (Cat) Six Falls, *Nelson 5035* (RM); La Platte Mines, *Nelson 5248* (RM).

Pohlia wahlenbergii sometimes has cells so large they are readily apparent in the dissecting microscope. The distinction from *P. ludwigii* is minimal, according to descriptions. *P. ludwigii* is recurved in the upper leaves, *P. wahlenbergii* is not. *P. ludwigii* does not form a definite border, *P.*

wahlenbergii apparently does not either! They both have equally large cells: see Andrews for discussion. The plain upper leaf margins distinguish *P. wahlenbergii* from both *P. drummondii* and *P. ludwigii*. The decurrencies on *P. wahlenbergii* are generally not as long, as distinctive: but occasionally they are (Nelson 4180).

Polytrichadelphus lyallii Mitt. = *Polytrichum lyallii* (Mitt.) Kindb.

POLYTRICHASTRUM G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971. (Polytrichaceae)

Polytrichastrum alpinum (Hedw.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971.
Polytrichum alpinum Hedw., Sp. Musc. Frond., 92, plate 19, fig. 2b. 1801.

Var. **alpinum**
Pogonatum alpinum (Hedw.) Roehl.
Pogonatum alpinum var. *arcticum* (Brid.) Brid.
Pogonatum alpinum var. *brevifolium* (R. Br.) Brid.
Pogonatum alpinum var. *campanulatum* (Hornsch.) P. Bruch & Schimp. in B.S.G.
Pogonatum alpinum var. *macounii* (Kindb.) Card. & Thér.
Pogonatum alpinum var. *simplex* Schimp.
Pogonatum alpinum var. *sylvaticum* (Menz.) Lindb.
Pogonatum furcatum (Hornsch.) Brid.
Polytrichum brevifolium R. Br.
Polytrichum ferrugineum Brid.
Polytrichum furcatum Hornsch.

The var. *alpinum* is not reported for Wyoming by FN A (FNA, Vol. 27, 2007); perhaps the following notes all pertain to var. *septentrionale* (Brid.) G. L. Smith, the only variety of *P. alpinum* noted for the state (FNA, Vol. 27, 2007): Throughout the Pacific Northwest; Alaska, California, Colorado: Minnesota, Wisconsin, Michigan; widespread in eastern North America from Labrador to North Carolina. (As var. *septentrionale*) Washington, Alberta, Montana, Wyoming; NorthW Territory, California, Utah, Colorado; Quebec, Nova Scotia.) (As *Pogonatum alpinum*) Brooklyn Lake, Lake Marie, Albany County; Battle Lake, Carbon County; and Tower Falls, Yellowstone Natl Park (Porter 1935). (As *Pogonatum alpinum*) "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, (Spence 1981). (As *Polytrichastrum alpinum* (Hedw.) G.L.Smith) Teton Co., Spence (1985). Sublette Co., Cooper & Andrus (1994). (as var. *septentrionale*) Albany, Carbon cos., Yellowstone Natl. Pk., Porter (1937). Carbon Co. (As *Pogonatum alpinum*) Battle Lake Mt., Aug 17 1897, *Nelson 4225* (Nelson 1900); Albany Co., 25Aug 1898, *Nelson 5170*; *Nelson 5233* (Nelson 1900). Crum & Anderson (1981:1268) consider this variety "...a stunted alpine expression from which the var. *brevifolium* can scarcely be distinguished"). See var. *brevifolium* in Flowers (1973). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Medicine Bow Mts., 9800 ft, *Lichvar 1333* (RM); on the stony shore of an alpine lake, Telephone Mines, 31 Jul 1900, *Nelson 7853,* papillose lamellae, see sub *Polytrichum sexangulare* (RM); Medicine Bow Mts., *Lichvar 1346* (RM). Big Horn Co.: 10,400 feet, *Fonken 994* (RM, BUF). Park Co.: Beartooth Plateau, 3200 m, *Weber, B–44315* (COLO, RM); SNG, Beartooth Plateau, alpine snow melt area, small lake in vast depression, ca. 100 m N of Beartooth Scenic Byway, N 44°58.510–515', W 109°27.165–170 ft, 3200 m, boggy shore crossed by rills, *Carex* spp.-Bryidae wetlands, wet tussocks, on clay soil, 20 Aug 2008, *Kosovich-Anderson 3508* (MHA, MO, RM). Sublette Co.: 11,200 ft, *Rolston 85098* (CSU); Bridger Wilderness, Wind River Range, Barnes

Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake with *Pohlia cruda,* 14 May 1989, *Andrus 7791b* (BING). Teton Co.: Absaroka Range, 9650 ft, *Hermann 25540* (RM).

This common taxon is distinctive under the hand lens for its long red awn and for the leaf margins broadly and sharply folded inward over the lamellae. With a lens and when dry, the leaf edges present a smooth, shining edge rather like a spruce needle.

Var. **septentrionale** (Brid.) G.L. Smith, Mem. N.Y. Bot. Gard. 21(3): 37. 1971.
Polytrichum septentrionale Brid., J. Bot. (Schrader) 1800(1): 285.1801.
Pogonatum alpinum var. *septentrionale* (Brid.) Brid.
Polytrichum alpinum var. *septentrionale* (Brid.) Lindb.
Polytrichum norwegicum Hedw.

Reported for Wyoming (FNA, Vol. 27, 2007).

[*Polytrichastrum formosum* (Hedw.) G.L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971, excluded]

[*Polytrichum formosum* Hedw., Sp. Musc. Frond., 92, plate 19, fig. 1a. 1801, excluded]
Polytrichum attenuatum Menzies.

Not reported for Wyoming (FNA 2007). See note under *Polytrichastrum longisetum* (Brid.) G.L. Smith

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Polytrichastrum longisetum (Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971.
Polytrichum longisetum Brid., J. Bot. (Schrader) 1800(1): 286. 1801.
Catharinea dixonii Braith. in Dix.
Catharinella dixonii (Braith.) Kindb.
Polytrichum attenuatum var. *aurantiacum* (Brid.) Turn.
Polytrichum aurantiacum Hoppe ex Brid.
Polytrichum formosum var. *aurantiacum* (Brid.) C. J. Hartm.
Polytrichum formosum var. *gracile* (Dicks.) Vent. & Bott.
Polytrichum gracile Dicks. in Menz.
Polytrichum gracile var. *anomalum* (Milde) I. Hagen

Reported for Wyoming (FNA, Vol. 27, 2007). Ireland (1982: 684) reported *Polytrichum formosum* Hedw. for Wyoming, with the synonym *Polytrichum gracile* var. *anomalum* (Milde) Hag.. The specimen on which this report is based may be *Polytrichastrum longisetum. (As Polytrichum longisetum)* On soil from the lowlands to over 3300 m British Columbia, Montana, Wyoming; Alaska, California, Colorado, Arizona; Manitoba, Ontario, Minnesota, Wisconsin, Michigan, Illinois; Quebec, New England, and North Carolina. (As *Polytrichum gracile* Dicks.) Sylvan Geysers, Yellowstone Natl Park, (*Nelson 6175*), Porter (1935). (As *Polytrichum gracile* Dicks.) Yellowstone Natl Park, Porter (1937). *(As Polytrichum longisetum)* Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: *(As Polytrichum longisetum)* Beartooth Mts., 9700 ft, *Hartman 18542* (RM). Sublette Co.: *(As Polytrichum longisetum)* Bridger Wilderness, Wind River Range Terrace fen on Baldy Creek, 10,110 ft,42°58'N, 109°35'W, 16 May 1989, *Andrus 7856* (BING). Yellowstone Natl Park: *(As Polytrichum longisetum)* Sylvan Geysers, *Nelson & Nelson 6175* (RM); *Nelson & Nelson 6175* (RM).

When making sections of this moss, be careful to do it near midleaf, since the lamellae seem to be fewer in the upper and lower parts of the leaf, and one might be mislead into *Atrichum* or *Oligotrichum* (lamellae less than 20). Look at the number without sectioning by viewing the ventral surface at midleaf.

Polytrichastrum sexangulare (Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971.
Polytrichum sexangulare Brid., J. Bot. (Schrader) 1800(1): 285. 1801.

Var. **sexangulare**
Polytrichum crassisetum Lam. & DC.
Polytrichum norvegicum auct. mult. non Hedw.
Polytrichum sexangulare var. *nivale* Kindb. in Roell

Wyoming (FNA, Vol. 27, 2007). (As *Polytrichum sexangulare*) On soil in the mountains from about 1300 m to over 3300 m British Columbia, Washington, Alberta, Montana, Wyoming; reported from Alaska and Greenland. Brooklyn Lake, Albany Co. (*Nelson 5232*); Telephone Mines, Albany County (*Nelson 7853*); and Ten Sleep Lakes, Big Horn County (*Goodding 427*), Porter (1935). I found *Nelson 7853* to have papillae on the lamellae and so to be *Pogonatum alpinum* var. *septentrionale* (Sw.) Brid. Park Co.: *Polytrichastrum sexangulare* was reported growing with *Polytrichum juniperinum, Brachythecium brandegeei* and *Sanionia nivalis* (Kosovich-Anderson & Weber 2011). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Polytrichum sexangulare*) ALBANY CO.: La Plata Mines, 28 Aug 1898, *Nelson 5232* (RM).

The species can be confused with *Pogonatum alpinum* var. *septentrionalis*, but for the papillose lamellae. The urns both appear to be small and round. The *5232* specimen showed little if any ridges in the urns—they were round (young?).

POLYTRICHUM Hedw., Sp. Musc. Frond., 88. 1801. (Polytrichaceae)

Polytrichum commune Hedw., Sp. Musc. Frond., 88. 1801.

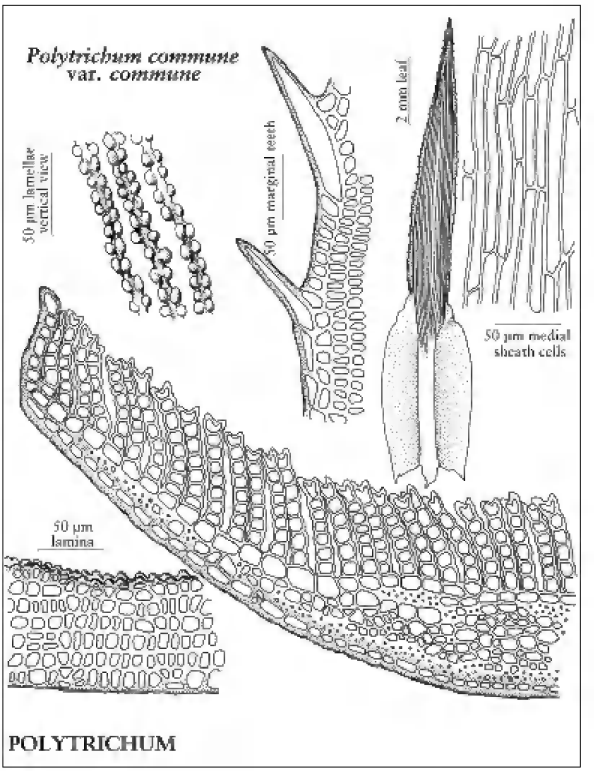
Var. **commune**
Polytrichum commune var. *uliginosum* Wallroth
Polytrichum commune var. *maximoviczii* Lindb.

Wyoming (FNA, Vol. 27, 2007). Sylvan Geysers, Norris, in Yellowstone Natl Park (*Nelson 6182 & 6144*). Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Yellowstone Natl Park: *Norris 6144* (RM); 7 Jul 1934, *Frye s.n.*, (RM); 6 Jul 1934, *Frye s.n.* (RM); Sylvan Geysers, 26 Jul 6182 (*Nelson 1900*).

Specimens of *Polytrichum commune* need to be reexamined to consider the variety *perigoniale* (Michx.) Hampe and *P. jensenii* I. Hagen. In Utah the species grows "on damp soil, edges of woods, bogs, and banks of brooks and ponds" (Flowers 1973). Reported as uncommon in Colorado (Weber & Whittmann 2007) and such is probably also the case in Wyoming. In Utah, Flowers (1973) wrote "from the abundant specimens collected by Jones in 1889, it would appear that this moss was plentiful at that time, but repeated explorations of the Brighton and Alta basins have

not revealed the moss in more recent times. The disappearance of certain ferns in the same areas suggests that a decline in average annual precipitation may be the main factor. Since 1924 I have noted a marked decrease in the abundance and vigor of the vegetation as a whole."



Courtesy FNA Association, FNA 27, 2007

Polytrichum commune var. **perigoniale** (Michaux) Hampe, Linnaea 13: 44. 1839.
Polytrichum perigoniale Michaux, Fl. Bor.-Amer. 2: 293. 1803.

Wyoming (FNA, Vol. 27, 2007).

Care must be taken with the map accompanying this variety in FNA 2007, as it does not correspond with the extensive distribution listed. The map indicates an Atlantic Coastal Plain distribution, but the variety also occurs in the plains states (Missouri, Oklahoma) and the Pacific Northwst in Washington State, British Columbia, the Yukon and Wyoming.

Polytrichum commune var. maximoviczii Lindb. = Polytrichum commune Hedw. var. commune

Polytrichum formosum Hedw. = Polytrichastrum formosum (Hedw.) G. L. Smith

Polytrichum gracile var. anomalum (Milde) I. Hagen = Polytrichastrum longisetum (Brid.) G. L. Smith

Polytrichum jensenii I. Hagen, Meddel. Grønland 15: 444. 1897.
Polytrichum commune var. *jensenii* (I. Hagen) Mönk.
Polytrichum commune var. *diminutum* (I. Hagen) D. H. Long
Polytrichum commune var. *yukonense* (Card. & Thér.) Frye
Polytrichum yukonense Card. & Thér.

Reported for Wyoming (FNA, Vol. 27, 2007). (As *Polytrichum jensenii* Hagen.) On the shore of Beaver Lake, Yellowstone Natl Park (*Nelson 6131*). "This is the plant which is discussed at length by Holz. (1900). It is apparently the only record for the United States," Porter (1935).

Specimen at RM: as *P. jensenii* Hagen, *Nelson & Nelson 6131*, Yellowstone Natl Park—in great open beds on the shore of the lake (Beaver Lake) *Jul 24 1899*. An annotation on the label reads: "discussed in Asa Gray Bulletin Vol. 8, p. 95 (1900). This specimen has large cuticular knobs on the terminal cells of the lamellae and teeth were not evident." The discription of the terminal cell does not match those of *P. jensenii*. The species should be considered rare in Wyoming.

Polytrichum juniperinum Hedw., Sp. Musc. Frond., 89, plate 18, figs. 6–10. 1801.
Polytrichum alpestre Hoppe
Polytrichum juniperifolium Funck
Polytrichum juniperinum var. *alpestre* (Hoppe) Röhling
Polytrichum juniperinum var. *alpinum* Schimp.
Polytrichum juniperinum var. *waghornei* Kindb.

Wyoming (FNA, Vol. 27, 2007). On soil or soil over rock, from the lowlands to over 3300m. In all states and provinces of the Pacific Northwest; widespread in the Middle West, and in eastern North America from Greenland and Labrador to North Carolina. Fairly common throughout the State; Albany, Crook, Sheridan, Teton cos., Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). Campbell Co., Medina (1994). Sublette Co. (Cooper & Andrus (1994)). Park Co. *Polytrichum juniperinum* was reported growing with *Plagiomnium ellipticum, Sarmentypnum exannulatum, S. sarmentosum and Sanionia nivalis;* in another site growing with *Polytrichastrum sexangulare, Brachythecium brandegeei* and *Sanionia nivalis* (Kosovich-Anderson & Weber 2011). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 9200 ft, spruce fir zone, *Porter 9697* (RM). Carbon Co.: 9400–10,000 ft, *s.n. 4136* (RM, BUF). Big Horn Co.: Big Horn Mtns., ca. 1 air mi SW of Tyrrell Ranger Station, sec 25 & 36, east-facing slope, 8800 ft, 21 Jun 1979, *Hartman & Odasz 9149* (BUF); *Nelson 4868* (RH, BUF). Fremont Co.: near border with Teton Co., between Moran and Dubois twps., on US 26, E of Togwotee pass, ca. 9000 ft, S-facing; spruce and 2 & 5-needle pines, herbaceous, not species abundant slope, *Artemisia tridentata* here and there, on soil, 6 Jul 1985, *Eckel s.n.* (BUF). Park Co.: (Yellowstone Natl. Pk.) *Hermann 12779 (*RM, BUF). Sheridan Co.: 8100 ft, *Nelson 4505 (*RH, BUF). Sublette Co.: 10,324 ft, *Rolston 85128* (CSU). Teton Co.: 7000 ft, *Hermann 25560* (RM). Yellowstone Natl Park: 8200 ft, *Taylor 67–155* (RM); "La Plata Mines," *Nelson 5231* (RM).

Polytrichum juniperinum var. affine (Funck) Brid. = Polytrichum strictum Brid.

Polytrichum longisetum Brid. = Polytrichastrum longisetum (Brid.) G. L. Smith

Polytrichum lyallii (Mitt.) Kindb. = Meiotrichum lyallii (Mitt.) G. L. Smith

Polytrichum piliferum Hedw., Sp. Musc. Frond., 90. 1801.

Wyoming (FNA, Vol. 27, 2007). Wyoming: Yellowstone Natl Park, sterile (1528) (Roell 1893). Albany, Carbon, Teton cos., Yellowstone Natl. Pk., Porter (1935 & 1937. "Common in front of glaciers", Teton Range, Grand Teton Natl Park, Wyoming, (Spence 1981). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: (Willow Creek), *Nelson 2919* (RM); 10,000 ft, Medicine Bow Mts., *Hermann 17695* (RM). Bighorn Co.: 10,000–10,400 ft, Big Horn Mts., *Odasz 737* (RM). Carbon Co.: summit Bridger Peak, 11,000 ft, *Porter 1731* (RM). Park Co.: 8600–9400 ft, *20702* (BUF, RM). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1/2 mi SW of Barnes Lake, 9760 ft, 42°57'N, 109°36'W, terrace fen, on N-facing rock at edge of fen with *Pohlia cruda*, 15 May 1989, *Andrus 7817b* (BING). Teton Co.: 7000 ft, *Hermann 25559* (RM). Yellowstone Natl Park: *Nelson & Nelson 6369* (RM); *Goodding 1983* (RM); "La Plata Mines," *Nelson 1768* (RM).

Polytrichum sexangulare Floerke ex Brid. = Polytrichastrum sexangulare (Brid.) G. L. Smith

Polytrichum strictum Brid., J. Bot. (Schrader) 1800(1): 286. 1801.
Polytrichum affine Funck
Polytrichum juniperinum var. *affine* (Funck) Brid.
Polytrichum juniperinum var. *gracile* Wahlenb.
Polytrichum juniperinum var. *strictum* (Brid.) Roehl.

Wyoming (FNA, Vol. 27, 2007). Wyoming: Yellowstone Natl Park, sterile (1527) (Roell 1893). Usually in bogs, often with *Sphagnum*, from the lowlands to about 2400 m British Columbia, Washington, Alberta, Montana, Wyoming; Alaska, Yukon; New England. Woods Creek, Albany County (Nelson 2071); Mirror Lake, Albany County (Porter 1276); Little Goose Creek, Sheridan County (Nelson 2363), Porter (1935). Sublette Co., "occupies the tops of hummocks and other seasonally dry habitats," Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Wood's Creek, 11 Aug 1896, *Nelson 2071* (RM). Crook Co.: Sundance Mtn., *Nelson 2180* (RM); Sundance Mtn., 3 Jul 1896, *Nelson s.n.*, (RM). Park Co.: Beartooth Mts., *Hartman 18541* (RM); Beartooth Plateau, 3250 m, *Weber B–44259* (COLO, RM). Sheridan Co.: Little Goose Creek, 16 Jul 1896, *Nelson 2363* (RM). Sublette Co.: In a peaty situation above the Lower Green River, 7950 ft, *Herman 25343,* a sterile specimen, but with characteristic white rhizoids (RM).

Pottia heimii (Hedw.) Hampe = Hennediella heimii (Hedw.) R.H. Zander

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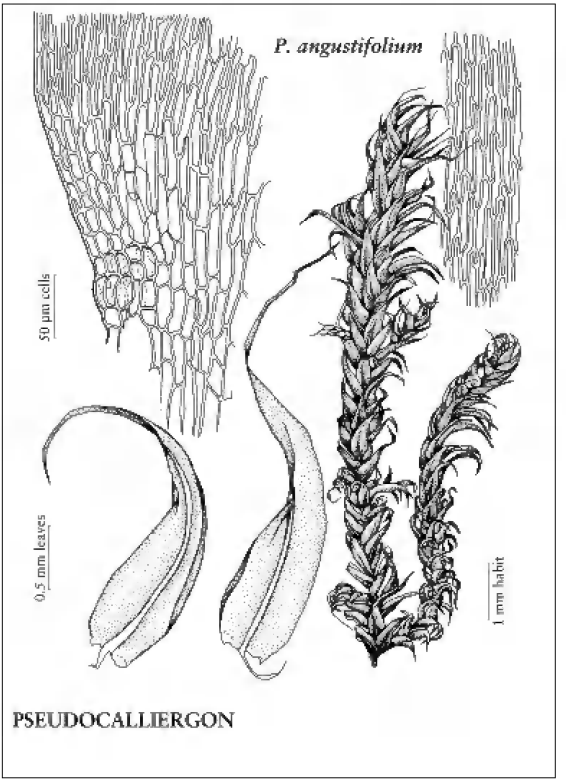
PSEUDOCALLIERGON (Limpr.) Loeske, Hedwigia 46: 311. 1907. (Amblystegiaceae)
Hypnum sect. Pseudocalliergon Limpr., Laubm. Deutschl. 3: 547. 1899 (as Pseudo-calliergon)

Pseudocalliergon angustifolium Hedenäs, Lindbergia 16: 85, fig. 1. 1992 (as augustifolium)
Drepanocladus angustifolius (Hedenäs) Hedenäs & c. Rosborg

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

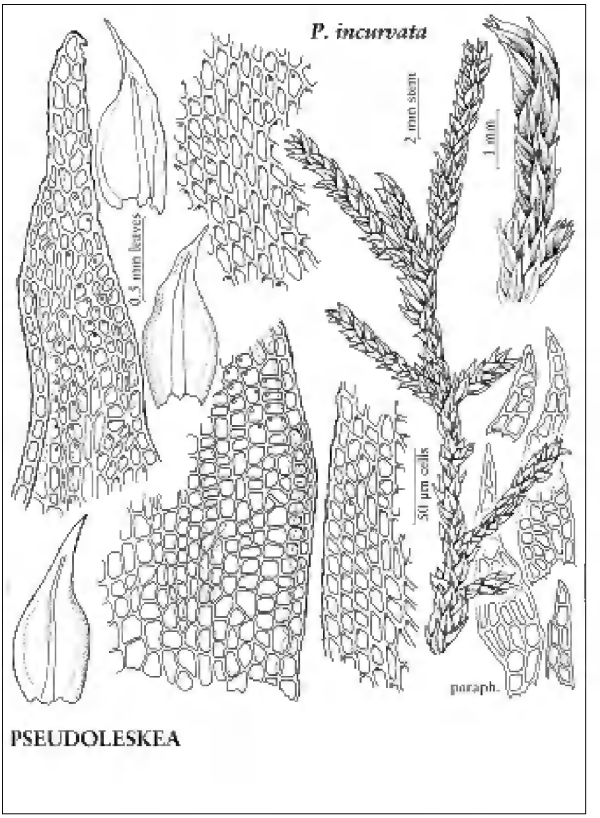
Pseudocalliergon trifarium (F. Weber & D. Mohr) Loeske, Hedwigia 46: 311. 1907.
Hypnum trifarium F. Weber & D. Mohr in F. Weber, Naturh. Reise Schweden, 177, plate 2, fig. 2. 1804.
Calliergon trifarium (F. Weber & D. Mohr) Kindb.
Drepanocladus trifarius (F. Weber & D. Mohr) Broth. ex Paris
Scorpidium trifarium (F. Weber & D. Mohr) H. K. G. Paul

Not reported for Wyoming according to FNA (FNA, Vol. 28, 2014). (As *Calliergon trifarium*) Sublette Co., Cooper & Andrus 1994.

Pseudocalliergon turgescens (T. Jensen) Loeske, Hedwigia 46: 311. 1907.
Hypnum turgescens T. Jensen, Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1858: 63. 1858.
Calliergon turgescens (T. Jens.) Kindb.
Scorpidium turgescens (T. Jens.) Loeske

Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: (As *Scorpidium turgescens*) alpine bogs, 3250 m, *Weber, B–44257* (RM, COLO).

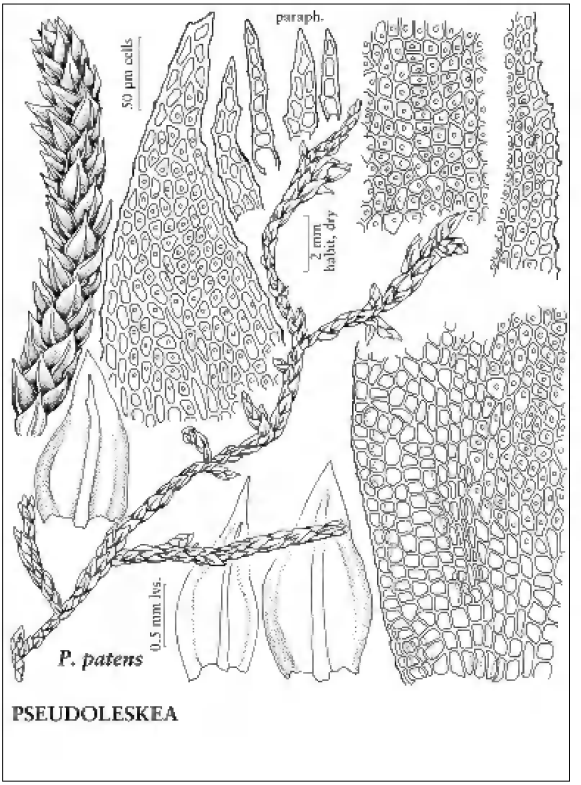


Courtesy FNA Association, FNA 28, 2014

PSEUDOLESKEA Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 147, plates 477, 478. 1852. (Leskeaceae)

Pseudoleskea incurvata (Hedw.) Loeske, Hedwigia 50: 313. 1911.
Leskea incurvata Hedw., Sp. Musc. Frond., 216, plate 53, figs. 8–14. 1801.

The species and varieties are not reported for Wyoming in FNA (FNA, Vol. 28, 2014). (As *Pseudoleskea atrovirens*) Yellowstone Natl Park, specimen numbers *1535–36a*, and *1539* (Roell 1893); also as var. *brachyclada*, specimen number *1536*; also as subspecies *rigescens* (Wils.) Lindb. (*1538*) (Roell 1893). (As *Pseudoleskea oligoclada* Kindb.) Centennial, Albany County (*Nelson 1724*); Corral Ranger Station, Carbon Co. (*Porter 930*), (Sheridan Co.), Porter (1935). (As *Lescuraea incurvata* (Hedw.) Lawt. var. *incurvata*) Wyoming, Flowers (1973). (As *Lescuraea incurvata* (Hedw.) Lawt.) Teton Co., Spence, l985.



Courtesy FNA Association, FNA 28, 2014

Carbon Co.: W slope of the Sierra Madre, in Battle Creek Canyon, 8500 ft, streamside forest of Engelmann spruce, moist rocks, 18 Aug 1964, *Porter & Porter 9715* (RM). Sublette Co.: , Shannon Pass, above Peak Lake, Wind River Mountains, Jim Bridger Wilderness, 43°08'N., 109°42'20" W, 3414 m, 23 Aug 1985, *Rolston 85110* (BUF, CSU); Bridger Wilderness, Wind River Range, Lake Sequa, 9940 ft, 42°57'30"N, 109°34'W, rock on shore, 17 May 1989, *Andrus 7881* (BING).

Pseudoleskea patens (Lindb.) Kindb., Canad. Rec. Sci. 6: 20. 1894.
Lescuraea patens Lindb., Meddeland. Soc. Fauna Fl. Fenn. 14: 75. 1888.

Wyoming (FNA, Vol. 28, 2014). (As *Lescuraea patens*) Lawton. (As *Lescuraea patens* (Lindb.) Arn. & Jens.) Wyoming, Flowers (1973). (As *Lescuraea patens*) Ireland (1982).

Lincoln Co.: on basalt outcrop along Greys River, 1/2 mi N of North Twin Creek, 6700 ft, Salt River Range, 36 mi SSE of Alpine Junction, 30 Aug 1973, *Hermann 25599* (RM) (dupl. det. Lawton).

Pseudoleskea radicosa (Mitt.) Macoun & Kindb., Cat. Canad. Pl., Musci 181. 1892.
Hypnum radicosum Mitt., J. Linn. Soc., Bot. 8: 31. 1864.
Lescuraea radicosa (Mitt.) Mönk.

Wyoming (as var. *radicosa)* (FNA, Vol. 28, 2014). Leigh Lake, Teton Co. (*Porter 1177* & *1175*), Porter (1935). (As *Lescuraea radicosa* (Mitt.) Mönk.) Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Var. **radicosa**

Albany Co.: vertical face of granite boulder on aspen slope, along N Fork of Little Laramie River, Sand Lake Rd., 8500 ft, Medicine Bow Mts., ca. 3 mi W of Centennial, 4 Aug 1962, *Hermann 17742* (RM). Fremont Co.: thin soil on boulder on spruce-fir slope, Burroughs Creek Road, 8400 ft, Absaroka Range, 14 mi N of Dubois, 28 Aug 1973, *Hermann 25523* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, 42°57'30", 109°36'W, Barnes Lake, 9747 ft, 1/4 mi S of Timico, on soil, 19 May 1989, *Andrus 7897* (BING). Teton Co.: on US 26 & US 287, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl Forest, ca. 9000 ft, *Picea-Pinus flexilis, Pinus contorta* var. *latifolia*, xeric, some *Artemisia*, with *Pohlia nutans*, 6 Jul 1985, *Eckel 94081602* (BUF).

Weber (1973) indicated this var. "seems to be intolerant of the drier conditions of the lower forested slopes and so far has been found only in the subalpine zone."

Var. **compacta** Best, Bull. Torrey Bot. Club 27: 231. 1900.
Lescuraea radicosa var. *compacta* (Best) Lawton
Pseudoleskea pallida Best

Wyoming (FNA, Vol. 28, 2014). (As *Lescuraea radicosa* var. *compacta* (Best) Lawt.) in Lawton (1971).

Var. **denudata** (Kindb.) Wijk & Margadant, Taxon 9: 191. 1960.
Pseudoleskea sciuroides var. *denudata* Kindb. in J. Macoun and N. C. Kindb., Cat. Canad. Pl., Musci 181. 1892.

Wyoming (FNA, Vol. 28, 2014).

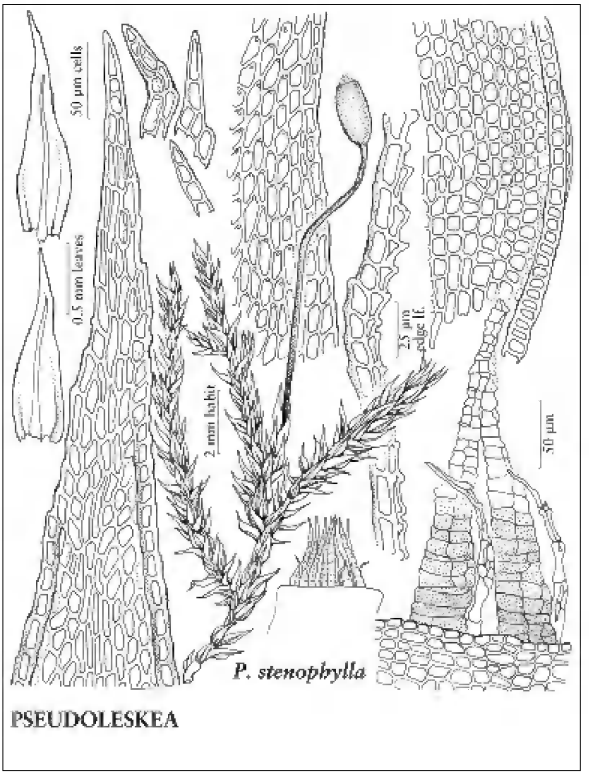
Var. **pallida** (Best) Crum, Steere & Anderson

(As *Lescuraea radicosa* var. *pallida* (Best.) Lawt.) in Lawton (1971).

This variety is not reported in FNA Vol. 28, 2014, but may be var. *compacta,* q.v.

Pseudoleskea stenophylla Ren. & Card., Bot. Centralbl. 44: 421. 1890.
Lescuraea stenophylla (Ren. & Card.) Kindb.

(As *Pseudoleskea atrovirens* subsp. *P. rigescens* (Wils.) Lindb. Yellowstone Natl Park, *1538* (Roell 1893). (As *Lescuraea stenophylla* (Ren. & Card.) Kindb.) Teton Co., Spence (1985) (citing a Flowers specimen).



Courtesy FNA Association, FNA 28, 2014

PSEUDOLESKEELLA Kindb., Eur. N. Amer. Bryin., 47. 1897. (Leskeaceae)

Pseudoleskeella nervosa var. sibirica (H. Arnell) Lawton = Pseudoleskeella rupestris (Berggren) Hedenäs & L. Soderström

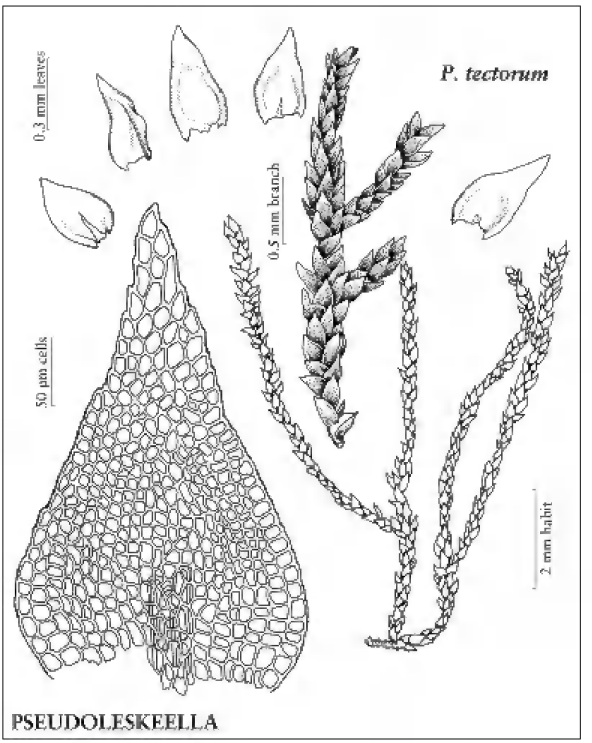
Pseudoleskeella rupestris (Berggren) Hedenäs & L. Soderström, Lindbergia 17: 64. 1992.
Leskea rupestris Berggren, Acta Univ. Lund. 3(7): 9, figs. 10–13. 1866.
Leskeella nervosa var. *sibirica* (Arnell) Lawton
Pseudoleskeella sibirica (Arnell) P. S. Wils. & D. H. Norris

Wyoming (FNA, Vol. 28, 2014).

Pseudoleskeella tectorum (Funck ex Brid.) Kindb. ex Broth. in H. G. A. Engler and K. Prantl, Nat. Pflanzenfam. 229 (I,3): 997. 1907.
Hypnum tectorum Funck ex Brid., Bryol. Univ. 2: 582. 1827.
Leskea tectorum var. *flagellifera* Best
Leskea williamsii Best
Leskea williamsii var. *flagellifera* Best

Leskella tectorum (Brid.) Hag.
Pseudoleskea tectorum (Funck ex Brid.) Schimp.

Wyoming (FNA, Vol. 28, 2014). (As *Leskea tectorum* var. *flagellifera*) Rogers Canyon, Albany County (*Porter 1286);* Yellowstone Falls, Yellowstone Natl Park (*Porter 1245*), Porter (1935). (As *Pseudoleskeella williamsii* (Best) Crum, Steere & Anderson. (As *Leskeella williamsii* Best) Near Fox Park, Albany Co. (*Porter 1267*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Albany Co.: NW base of Sheep Mountain along WY11, ca. 4 air mi ESE of Centennial, seep are (calcareous fen) with *Populus, Betula* and *Salix*, *Buck 23242* (NY); Laramie Mountains, Roger Canyon, 8 air mi NE of Laramie city center, 7850–8000 ft,on thin soil over limestone boulder, 7 Jun 1993, *Miller 10,247* (NYS). Fremont Co.: limestone outcrop, Douglas fir slope, 1/2 mi E of Horse Creek Campground, 7800 ft, Absaroka Range, 11 mi N Dubois, with *Tortella tortelloides, Gymnostomum aeruginosum,* 28 Aug 1973, *Hermann 25530* (WTU). Natrona Co.: Hat Six Falls, SE of Casper, 7 Aug 1897, *Nelson 5036* (RM). Sheridan Co.*:* on vertical rock face, moist limestone, Big Horn Natl Forest, T57N, R89W, Sect. 27, 16 Jun 1992, *McKee 92–020* (BUF, RM). Weston Co.: *Eckel 923686* (RM).

This moss is distinct from others in the Leskeaceae by its frequently having no costa in smaller branch leaves. Otherwise, species of the Leskeaceae appear to all have strong costae into the acumen. *Lindbergia brachyptera* has a long acuminate apex, unlike *Pseudoleskeella tectorum*. *Brachythecium collinum* fruits readily around early July, whereas *P. tectorum* seldom does. The former species has a single costa and is regularly and distinctly serrate usually to the base: *P. tectorum* is generally entire except in young leaves where it may be somewhat serrulate in the apex. *Pseudoleskeella tectorum* is characterized by an eagerness to develop reduced leaves, yielding branches flagelliform in appearance. This species reminds one of the flagellate-attenuate branch ends of *Anomodon attenuatus* in the East. *Anomodon* is not an element of the western flora. *Homomallium adnatum*, the other species in that genus, is also an eastern taxon.

PTERYGONEURUM Juratzka, Laubm.-Fl. Oesterr.-Ung., 95. 1882 (as Pterigoneurum), name and orthography conserved. (Pottiaceae)

Pterygoneurum ovatum (Hedw.) Dixon, Rev. Bryol. Lichénol. 6: 96. 1934)
Gymnostomum ovatum Hedw., Sp. Musc. Frond., 31, plate 2, figs. 1–3. 1801.
Pottia cavifolia Ehrh. ex Fuernr.
Pottia pusilla Lindb.

Wyoming (FNA, Vol. 27, 2007). British Columbia, Washington, Oregon, Idaho, Montana, Wyoming: Yukon, California, Nevada, Utah, Arizona, New Mexico, Colorado; Saskatchewan, North Dakota, Ontario, Quebec. (As *Pterygoneurum cavifolium* Jur.) On dry, sandy soil, Telephone Canyon, Albany Co. (*Porter 686*), Porter (1935).

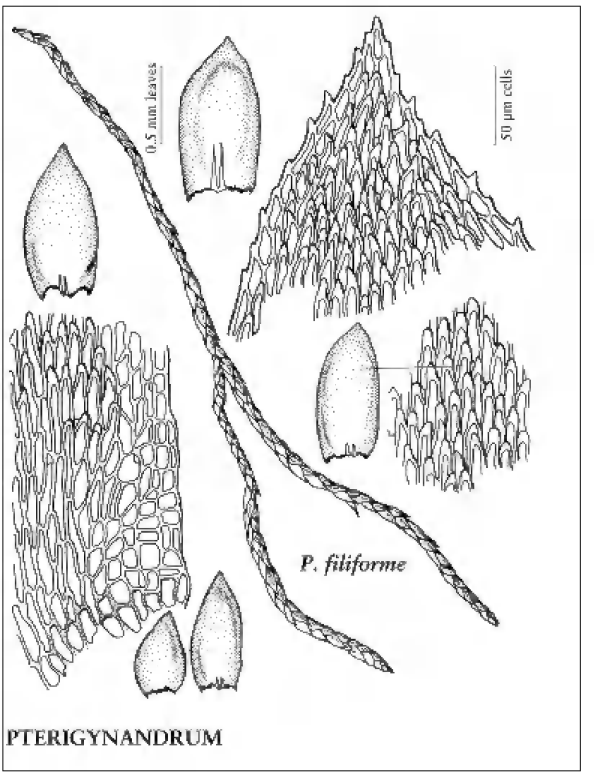
Albany Co.: NW base of Sheep Mtn along WY 11, sandstone outcrops and chugwater redbeds with *Artemesia,* 7 Jun 1993, *Buck 23220,* old fruit (NY). Crooke Co.: *Eckel 519686* (RM, BUF). Hot Springs Co.: *Eckel 123686* (RM, BUF). Lincoln Co.: on US189 just N of border with Uinta Co., S of town of Kemerer, open sage prairie, *Sarcobatus vermiculatus*, on dirt polygons below shrubs, mixed with *P. subsessile*, 4 Jul 1985, *Eckel 94082205* (BUF). Natrona Co.: from soil on south bank of river shaded by slight overhang and tall grass in very dry land, sagebrush, bunchgrass habitat, 22 Mar 1996, *Hoy 315* (BUF). Sweetwater Co.: ca. 6400 ft, on US (187)191, at 14-Mi Reservoir picnic area in *Artemisia* scrubland, moist shaded ravine over brook, with *Hennediella heimii, Leptobryum pyriforme, Campylium chrysophyllum*, 5 Jul 1985, *Eckel 312086* (BUF).

Pterygoneurum subsessile (Brid.) Juratzka, Laubm.- Fl. Oesterr.-Ung., 96. 1882.
Gymnostomum subsessile Brid., Muscol. Recent., suppl. 1: 35. 1806.
Gymnostomum acaule Floerke in Web. & Mohr
Pottia subsessile (Brid.) B.S.G.

British Columbia, Oregon, Idaho, Wyoming; Yukon, Nevada, Utah, Arizona; Saskatchewan, North Dakota, Oklahoma, Texas, Minnesota.

Albany Co.: Laramie Plains, 2 mi NE of Laramie, chugwater redbeds with *Astragalus, Eriogonum, Penstemon* and grasses, 7 Jun 1993, *Buck 23188,* c.fr., old but intact, dehisced (NY); open prairie, low grasses and forbs, ca. 7300 ft, rim of breaks, among grasses, *Reese 18164* (LAF); Laramie Plains, 2 mi NE of Laramie center, chugwater redbeds, rim of breaks, 7250–7300 ft, bare prairie soil between herbs, including *Astragalus, Eriogonum, Penstemon*, 7 Jun 1993, *Miller 10251* (NYS). Goshen Co.: 4350 ft, *Eckel 871112* (BUF). Hot Springs Co.: *Eckel 323686* (RM). Laramie Co.: *Eckel 871113* (RM, BUF). Lincoln Co.: on US189 just N of border with Uinta Co., S of town of Kemerer, open sage prairie, *Sarcobatus vermiculatus*, on dirt polygons below shrubs, mixed with *P.*

ovatum, 4 Jul 1985, *Eckel 94082206* (BUF). Niobrara Co.: 5000 ft, *Eckel 871102* (RM). Sublette Co.: on US 191, 1.7 mi N of jct. with US 189, *Artemisia tridentata, Sarcobatus,* shadscale grassland, on soil, 5 Jul 1985, *Eckel 961254* (BUF, RM). Sweetwater Co.: on US (187)191, at 14 Mile Reservoir, picnic area, US Dept. Interior, dry slopes above pond, *Sarcobatus, Artemisia tridentata* scrub, with *Tortula caninervis* & *T. mucronifolia,* 5 Jul 1985, *Eckel 218186* (BUF, RM).



Courtesy FNA Association, FNA 28, 2014

PTERIGYNANDRUM Hedw., Sp. Musc. Frond., 80, plates 16, 17 18, figs. 1–5. 1801. (Pterigynandraceae)

Pterigynandrum filiforme Hedw., Sp. Musc. Frond., 81. 1801.

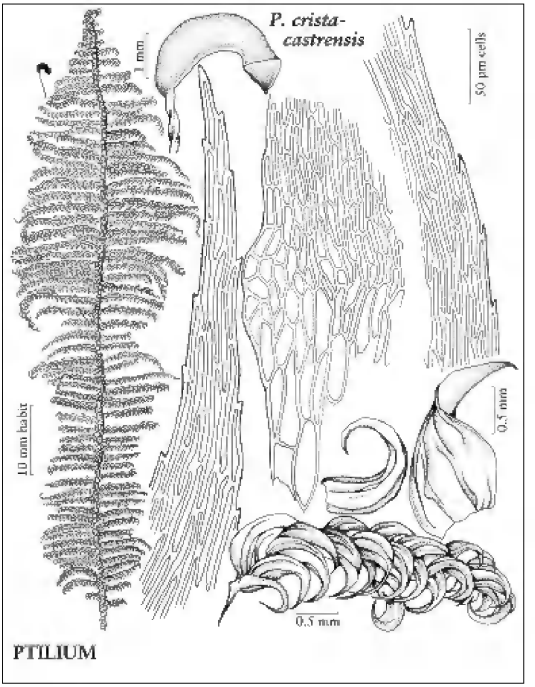
Wyoming (FNA, Vol. 28, 2014). Yellowstone Natl Park: a specimen was noted by Roell (1893) for the Park (*1534, 1537a*, and *1552*).

PTILIUM De Not., Comment. Soc. Crittog. Ital. 2: 283. 1867. (Hypnaceae)

Ptilium crista-castrensis (Hedw.) De Not., Comment. Soc. Crittog. Ital. 2: 283. 1867.
Hypnum crista-castrensis Hedw., Sp. Musc. Frond., 287, plate 76, figs. 1–4. 1801.

Wyoming (FNA, Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: W of Bear Tooth Butte Crazy Creek Campground, along Crazy Creek, 22 Aug 1953, *Lawton 2018* (WTU). Yellowstone Natl Park: Madison Junction, 18 Aug 1953, *Lawton 1900* (WTU).

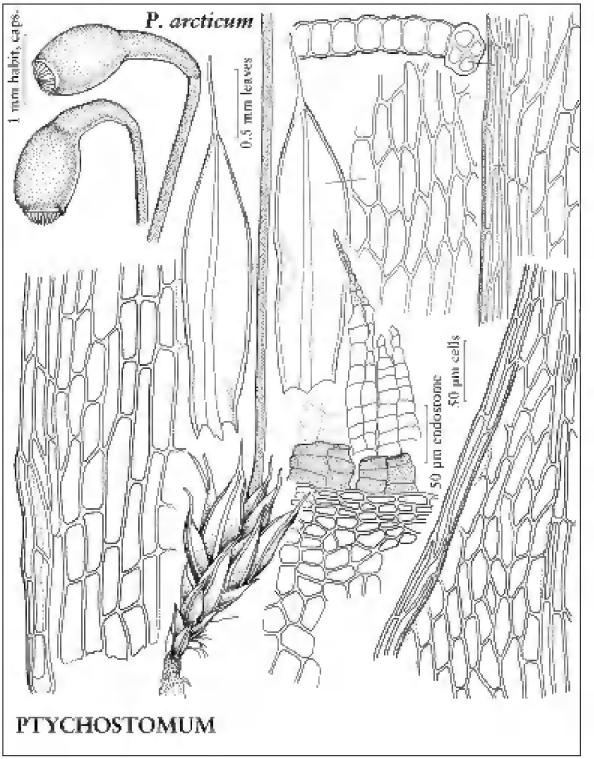


Courtesy FNA Association, FNA 28, 2014

PTYCHOSTOMUM Hornschuch, Syll. Pl. Nov 1: 62. 1822. (Bryaceae)

Ptychostomum arcticum (R. Brown) J.R. Spence, Phytologia 87: 20. 2005.
Pohlia arctica R. Brown, Chlor. Melvill., 38. 1823.
Bryum arcticum (R. Brown) P. Bruch & W.P. Schimper
Bryum bryoides (R. Brown) Ångstrom
Bryum purpurascens (R. Brown) P. Bruch & W.P. Schimper
Ptychostomum bryoides (R. Brown) J.R. Spence
Ptychostomum purpurascens (R. Brown) J.R. Spence

Wyoming (FNA, Vol. 28, 2014).



Courtesy FNA Association, FNA 28, 2014

Ptychostomum bimum (Schreber) J.R. Spence, Phytologia 87: 20. 2005.
Mnium bimum Schreber, Bot. Zeitung (Regensburg) 1: 79. 1802.
Bryum bimum (Schreber) Turner
Bryum pseudotriquetrum var. *bimum* (Schreb. ex Brid.) Lilj.

Wyoming (FNA 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Ptychostomum cernuum (Hedw.) Hornschuch, Syll. Pl. Nov 1: 64. 1822.
Cynontodium cernuum Hedw., Sp. Musc. Frond., 58, plate 9. 1801.
Bryum uliginosum (Brid.) P. Bruch & W.P. Schimper
Bryum cernuum (Sw.) Lindb.
Bryum conditum Williams
Bryum turbinatum var. *pallens* Drumm.
Cladodium uliginosum Brid.

Not reported for Wyoming in FNA (FNA, Vol. 28, 2014). "Reported from Wyoming," Lawton (1971). Teton Co., Spence (1985).

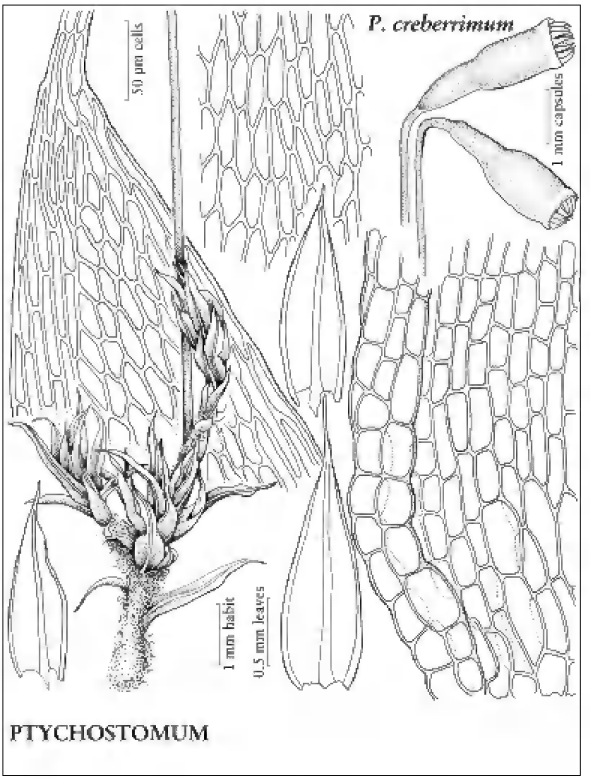
As *Bryum uliginosum,* Flowers (1973: 364) wrote: "The large curved capsule and large lax leaves make this moss easily recognizable." Note that, like *B. turbinatum*, it has large more or less lax cells and the margins are not recurved (plane) but, unlike *B. turbinatum,* which has no distinct border, *B. uliginosum* has cells "thin walled and lax, rather abruptly narrowly linear on the margins forming a strong border." Flowers also indicated a 6 mm long capsule!

Ptychostomum creberrimum (Taylor) J.R. Spence & H.P. Ramsay, Phytologia 87: 23. 2005.
Bryum creberrimum Taylor, London J. Bot. 5: 54. 1846.
Bryum alaskanum Kindb.
Bryum bimum var. *cuspidatum* B.S.G.
Bryum cuspidatum (B.S.G.) Schimp.
Bryum flagellosum Kindb.
Bryum hamicuspis Kindb.
Bryum intermedium (of American authors)
Bryum lisae var. *cuspidatum* (P. Bruch & W.P. Schimper) Margadant
Bryum manitobae Kindb.
Bryum nano-caespiticium Kindb.
Bryum neomexicanum Card.

Wyoming (FNA, Vol. 28, 2014). (As *Bryum lisae* var. *cuspidatum*) In all states and provinces of the Pac. NW; Alask., Cal., Nev., Ariz; widespread in the Midwest and in eastern North America. (As *Bryum intermedium* Brid.) Laramie Mts. Albany Co. (*Nelson 7274*); Centennial Valley, Albany Co. (*Nelson 1263*); Old Faithful, Yellowstone Natl Park, Porter (1935). Teton Co., Spence (1985). (As *Bryum cirrhatum* Hopp. & Hornsch.) Cummins, Homer Ranch, and Brooklyn Lake, all in Albany Co. (*Nelson 1538*, in part, *6955*, and *5235*) Porter (1937).

(All as *Bryum lisae* var. *cuspidatum*) Albany Co.: Centennial Valley, *Nelson 1263* (RM); Laramie Hills, *Nelson 7274* (RM, US); on the wet alkaline ditch banks, Homer's Field, exsiccat Plants of Wyoming, 30 May 1900, *Nelson 6955* (RM). Bighorn Co.: ca. 28.5 mi east of Greyville, ca. 19.5 mi NNE of Hyattville, 9200 ft, 9 Jul 1979, *Nelson 3334,* fruit operculate (BUF, RM); off Devil Canyon Rd. above Little Tepee Creek, on rotten logs, 8300 ft, with *Pohlia nutans, Leptobryum pyriforme* and *Distichium capillaceum, Nelson 3658a (*BUF); on disturbed soil just off US 16 between Tensleep & Buffalo (near Sitting Bull Campsite), *Pinus contorta* v. *latifolia* being lumbered, just N of Washakie Co. border, ca. 5000 ft, with *Ceratodon purpureus*, 6 Jul 1985, *Eckel 94092200* (BUF, RM). Fremont Co.: 8400 ft, *Hermann 25515* (RM). Park Co.: 7400 ft, *Hermann 20067* (RM). Park Co.: 6000 ft, 1 Apr 1988, *Vukelich s.n.* (BUF). Yellowstone Natl Park: (as *Bryum torquescens*) Druid Peak, Plants of Yellowstone Natl Park, growing amid fruiting *Pohlia nutans,* 12 Jul 1899, *Nelson & Nelson 5801,* synoicous, rosulate specimens, lance-acuminate leaves with long awns, not ovate or obovate (US, RM).

The specimen *Nelson 3658a* is unusual in that the neck of the capsule is, in some plants, as long as the urn. It has low teeth on the lamina margins and hairpoints, as *B. cirrhatum* is described by Crum and Anderson (1981: 556). In Europe this is considered alpine but there is no distinction in the USA in elevation.



Courtesy FNA Association, FNA 28, 2014

Ptychostomum cyclophyllum (Schwägr.) J.R. Spence, Phytologia 87: 20. 2005.

Mnium cyclophyllum Schwägr., Sp. Musc. Frond. Suppl. 2(2,2): 160, plate 194 (bottom). 1827.

Bryum cyclophyllum (Schwägr.) P. Bruch & W.P. Schimper

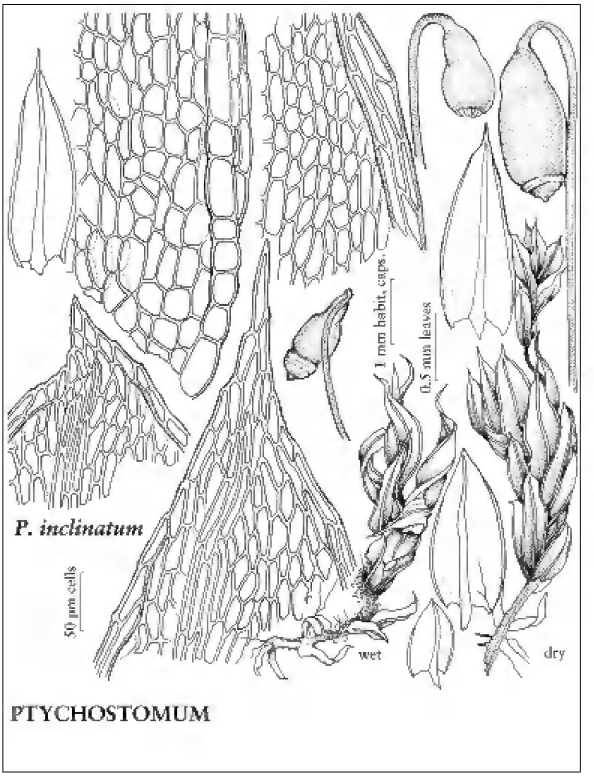
Bryum tortifolium Brid.

Mnium cyclophyllum Schwägr.

Wyoming (FNA, Vol. 28, 2014). (As *Bryum cyclophyllum*) Wash., Alberta, Wyoming; Alask., Yuk., Ariz; Missouri. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Fremont Co.: 9300 ft, *Hermann 25291* (RM). Park Co.: tundra, 10,000 ft, *Hermann 20070* (RM & WTU). Both specimens pink. Tends to a bright red with age.

"The occurrence of *P. cyclophyllum* has probably declined in the United States, as the plants grow in wetlands and along streams in mid elevation regions, areas where human development is often concentrated" (Spence in FNA Vol. 28, 2014). In one instance it was found confused with *B. gemmiparum* which has not yet been found in Wyoming. The latter is without red pigmentation (Crum & Anderson 1981), but most noteably is not or scarcely contorted when dry.



Courtesy FNA Association, FNA 28, 2014

Ptychostomum inclinatum (Sw. ex Brid.) J.R. Spence, Phytologia 87: 21. 2005.
Pohlia inclinata Sw. ex Brid., Muscol. Recent. 2(3): 144. 1803.
Bryum acutiusculum Müll. Hall.
Bryum amblyodon Müll. Hal.
Bryum edwardsianum Müll. Hall. & Kindb. in Macoun
Bryum froudei Kindb.
Bryum inclinatum (Brid.) Bland.
Bryum stenotrichum Müll. Hal.
Bryum stenotrichum var. *biddlecomiae* (Aust.) Lawt.
Cladodium inclinatum (Brid.) Brid.
Cladodium inclinatum (Sw. ex Brid.) Brid.

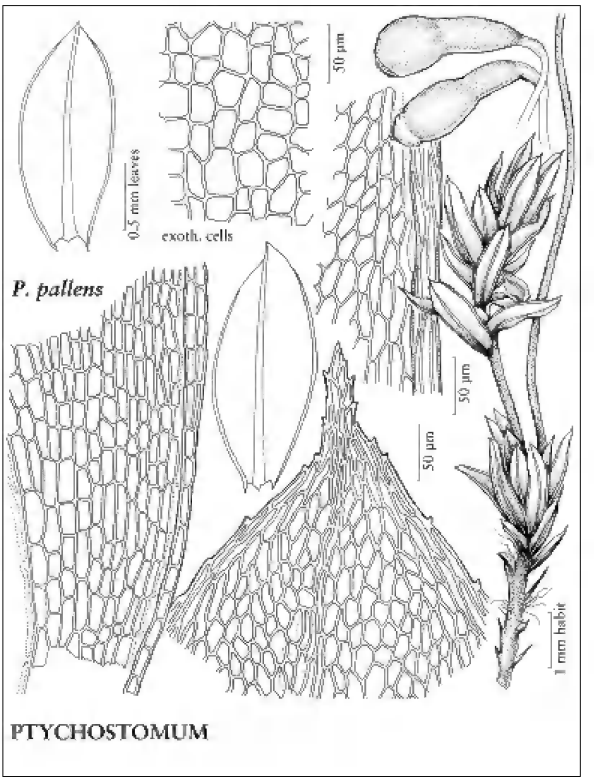
Wyoming (FNA, Vol. 28, 2014). (As *Bryum inclinatum*) Laramie Hills, Albany Co., Nelson (1928), Porter (1935). (As cf. *stenotrichum*) "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming, Spence (1981). Teton Co., Spence (1985).

Weber (1973) indicated this species "occurs commonly in the alpine tundra, where it may replace *B. pallescens* on drier sites." Note that *Bryum lisae* var. *cuspidatum*, which Flowers (1973:

370) indicates is in Utah "our commonest species of *Bryum.*" It is not reported as growing in Colorado by Weber (1973).

Ptychostomum knowltonii (Barnes) J.R. Spence, Phytologia 87: 21. 2005.
Bryum knowltonii Barnes, Bot. Gaz. 14: 44. 1889 (as knowltoni)

Wyoming (FNA, Vol. 28, 2014).



Courtesy FNA Association, FNA 28, 2014

Ptychostomum lonchocaulon (Müll. Hal.) J.R. Spence, Phytologia 87: 21. 2005.
Bryum lonchocaulon Müll. Hal., Flora 58: 93. 1875.

Wyoming (FNA, Vol. 28, 2014). (As *Bryum cirratum* (Hornsch.) Lindb.—although this may be a different taxon than one in synonymy with *P. lonchocaulon*). Wyoming: Yellowstone Natl Park, c.fr., (*1506, 1509, 1510*) (Roell 1893).

Spence (1988: 83) indicated that (*Bryum lonchocaulon*) is "an ecological variant of *B. lisae* with extremely long hairpoints." *Bryum cirrhatum* Hornsch. is in synonymy with *B. lonchocaulon* in the list of Anderson et al. (1990). "*Ptychostomum lonchocaulon* is very similar to *P. creberrimum*,

differing in sexual condition (polyoicous, mixed synoicous and with male-only gametangia vs. synoicous) and its stronger non-yellowish limbidium" (Spence in FNA 28, 2014).

Ptychostomum pallens (Sw.) J.R. Spence, Phytologia 87: 21. 2005.
Bryum pallens Sw., Monthly Rev. 34: 538. 1801.
Bryum anoectangium Müll. Hall. & Kindb. in Macoun
Bryum drepanocarpum Philib. in Card. & Thér.
Bryum heterogynum Philib. in Card. & Thér.
Bryum meesioides Kindb. in Macoun
Bryum subpurpurascens Kindb. in Macoun
Hypnum pallens (Sw.) Web. & Mohr
Pohlia pallens (Sw.) Brid.

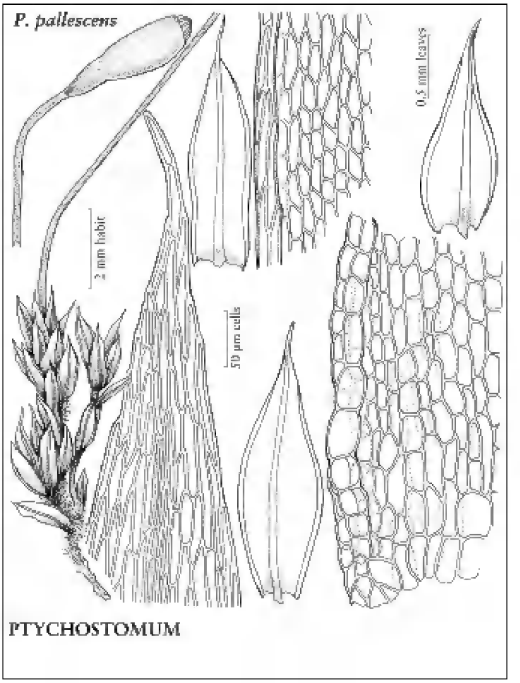
Wyoming (FNA, Vol. 28, 2014). (As *Bryum pallens*) Wyoming: Yellowstone Natl Park, c.fr., (*1505a*) (Roell 1893). (As *Bryum pallens*) B.C. Wash., Oregon, Wyoming; Newfoundland, Quebec, NY.

Ptychostomum pallescens (Schleicher ex Schwägr.) J.R. Spence, Phytologia 87: 21. 2005.
Bryum pallescens Schleicher ex Schwägr., Sp. Musc. Frond. Suppl. 1(2): 107, plate 75 (right). 1816.
Bryum microstegioides Kindb.
Bryum subrotundum Brid.

Wyoming (FNA, Vol. 28, 2014). (As *Bryum subrotundum*) Wyoming: Yellowstone Natl Park, parce sed fert. (sparing but fertile) (*1511*) (Roell 1893). (As *Bryum pallescens*) In all states and provinces of the Pacific Northwest; Cal., Nev., Colo. Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Bryum pallescens*) Albany Co.: Laramie Peak, in the shaded aspen groves, *Nelson 7536* (det. by Holz. as *B. bimum* Schreb., printed label, Plants of Wyoming) (RM); on humus on bank of small stream Medicine Bow Mtns, *Schriever 9* (RM). Big Horn Co.: Big Horn Mtns, off Devil Canyon Road above Little Tepee Creek, moist to wet meadow, 8300 ft, 13 Jul 1979, *Nelson 3652* mature capsules (RM, BUF). Carbon Co.: peaty knoll on shore of Lake Marie, 10,000 ft, Snowy Range, Medicine Bow Mts., 13 mi E of Ryan Park, 19 Aug 1961, *Hermann 17146* (US); Ferris Mountains, 25 Jul 1898, *Nelson 4980* c.fr., (as *B. cirratum*) cladautoicous plus free endostome (US). Johnson Co.: Big Horn Mtns., along Middle Fork Crazy Woman Creek, 8200 ft, 11 Jul 1979, *Nelson 3584,* c.fr., deoperculate (BUF, RM). Sheridan Co.: Big Horn Mtns., limestone outcrops and adjacent forest, 8000 ft, *Hartman 10253* (RM). Sublette Co.: 10,325 ft, *Rolston 85101* (CSU). Yellowstone Natl Park: Witch Creek Fire Scar W of Flat Mn, 8000 ft, hillside, dry area, *Taylor 67–159* (RM).

"Ptychostomum creberrimum is similar, but has smaller spores, synoicous sexual condition, and ovate segment perforations" (Spence in FNA Vol. 28, 2014). This plant has complex sexuality, with male buds on separate branches. The stems are many-branched and felted with rhizoides, unlike *B. lisae*. The fruiting stem may have an archegonium or two, and be apparently synoicous and then easy to mistake as *B. lisae*. The bulb-like habit of *B. caespiticium* with little branches should be looked at in comparison with this species. The Yellowstone specimen also had many branches, up to six, with innovations on the branches. One of the side branches of the fruiting stem bore archegonia and no antheridia could be found on the stem examined. If upon dissection, a plant of this type has copious antheridia, it is probably this species, not *B. lisae*. The cell dimensions are indistinguishable from those of *B. lisae,* frequently being quite long.



Courtesy FNA Association, FNA 28, 2014

Ptychostomum pendulum Hornschuch, Syll. Pl. Nov 1: 64. 1822.
Bryum algovicum Sendtner ex Müll. Hal.
Bryum pendulum (Hornsch.) Schimp.
Bryum roellii Philib.
Ptychostomum compactum Hornsch.

Wyoming (FNA, Vol. 28, 2014). (As *Bryum pendulum*) Wyoming: Yellowstone Natl Park, Upper Fall, 7000 ft, (*1500, 1507*) (Roell 1893). (As *Bryum algovicum*) British Columbia, Washington, Alberta, Idaho, Montana, Wyoming; NorthW Terr. Cal., Nev., Colo.; Sask., Manit., S. Dakota, Iowa, Nebr., Minn., Mich., Ont., Indiana; Quebec to District of Columbia. (As *Bryum angustirete* Kindb. ex Macoun in Lawton). (As *Bryum angustirete* Kindb.) Cokeville, Lincoln Co. (*Nelson 4656*), Porter (1935). (As *Bryum pendulum* Schimp.) Albany, Carbon, Johnson, Sheridan, Sweetwater cos., Porter (1935).

(As *Bryum algovicum*) Albany Co.: Centenial Valley, 17 Aug 1896, *Nelson 2654,* c.fr., small mouth obvious here (RM); also Sherman and Buford, wet granite swales, 27 Jul 1913, *Macbride 2547* (RM). Big Horn Co.: Big Horn Mtns., E-facing slope, 8800 ft, 21 Jun 1979, *Hartman & Odasz 9152*, c.fr., not dehisced (BUF, RM). Carbon Co.: rocky hillside, Rawlins, on flat, wet ground, 13 Jul 1942, *Degener 17,049*, c.fr. (US). Johnson Co.: Big Horn Mts., canyon along North Fork Crazy Woman Creek; calcareous boulders in creek and wet cliffs at edge of creek, 6600 ft, 6 Aug 1980, *Nelson 6837*, c.fr., half deoperculated (BUF, RM), with *Hymenostylium recurvirostrum*. Fremont Co.: in big spring about 4 mi E of Dubois, 23 Jun 1931, *Frye s.n.* (WTU); Steamboat Mountain, on a boggy flat,

9 Jun 1900, *Nelson 7045* printed label, Plants of Wyoming, det. by E.G. Britton and R.S. Williams, synoicous plus male buds on tips of branches, large spores, small mouths (RM).

The name *Bryum algovicum* is "reserved for the autoicous form and *B. algovicum* var. *rutheanum* (Warnst.) Crund. should be used for the synoicous form. We find that the species is actually polygamous (usualy syoicous but sometimes also producing perigonial buds on the same plants)" Crum and Anderson (1981: 544), so they reject the varieties. But see the most recent checklist (Anderson et al. 1990) where both varieties are recognized, cf. discussion in Crum and Anderson l981. "The name *B. angustirete* Kindb. ex Macoun (Bull. Torrey Bot. Club 16: 94 1889) has been rejected because the type could not be found either in Macoun's or Kindb.'s herbarium, and such specimens as occur in those herbaria under that name are not *B. algovicum*," (Crum and Anderson 1981: 544). Lawton's (1971) *B. angustirete* is synonymous with *Bryum pendulum*, as is Crum & Anderson's *B. algovicum*. It is through *Bryum pendulum* that I identify Lawton's references to *B. angustirete* with *B. algovicum*.

The Johnson Co. specimen had leaf cells shorter and thicker than those of *Bryum lisae* var. *cuspidatum* but not as short as those of *B. pseudotriquetrum*, which in addition has decurrencies. The peristome is peculiar as described.

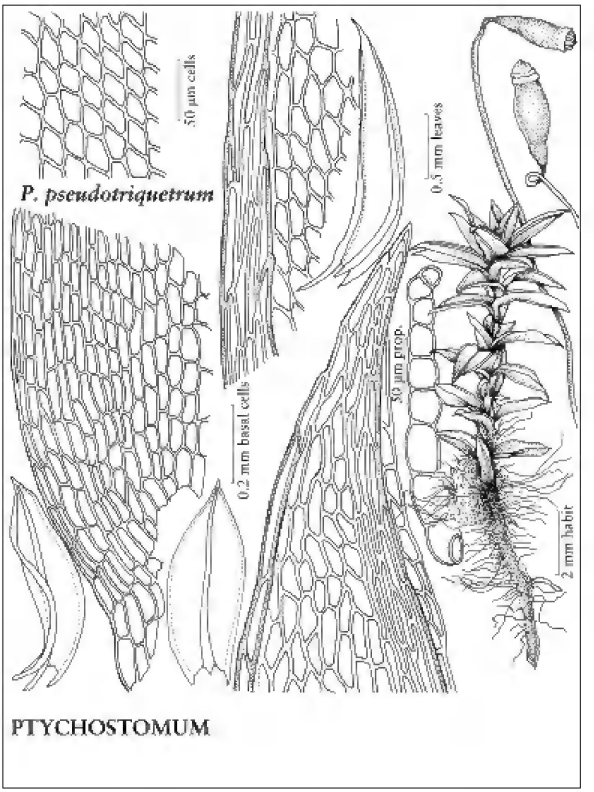
As *Bryum algovicum,* Spence (1988) wrote that the species "can be distinguished by its fused peristome, large spores, and small pendulous capsule with a small red mouth." It occurs at low elevations and in dry regions. The *Degener 17,049* specimen did have a small mouth, as Spence indicated, and with a nice red ring around it. The capsules appear to be as small as those of *B. caespiticium*, with which the Degener specimen had first been identified—but the stem was many branched and not rosulate (resembling *B. pallescens* in this regard) and not bulbous with long leaf apices as in *caespiticium.*

The *Nelson 4656* specimen mentioned by Porter above seen at (US) had capsules that were young, but the tufts were dense and green or yellow-green, as Crum & Anderson (1981: 542) indicated. The plant I examined was synoicous, note "innovations on fruiting plants often terminating in a perigonium"—which reminds me of *Bryum pallescens.* Capsules are definitely needed for identification (Spence in FNA Vol. 28, 2014).

Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P. Ramsay ex Holyoak & N. Pedersen, J. Bryol. 29: 120. 2007.
Mnium pseudotriquetrum Hedw., Sp. Musc. Frond. 190. 1801.
Bryum crassirameum Ren. & Card.
Bryum crassirameum Ren. & Card.
Bryum dimorphophyllum Card. & Thér.
Bryum euryloma Card. & Thér.
Bryum haematocarpum Müll. Hall. & Kindb. in Macoun
Bryum pseudotriquetrum (Hedw.) P. Gaertner, B. Meyer & Scherbius
Bryum pseudotriquetrum var. *crassirameum* Ren. & Card.
Hypnum pseudotriquetrum (Hedw.) Web. & Mohr

Wyoming (FNA, Vol. 28, 2014) "*Ptychostomum bimum* is smaller, with much weaker decurrencies, and is synoicous" (Spence in FNA, Vol. 28, 2014). (As *Bryum pseudotriquetrum*) Wyoming: Yellowstone Natl Park, (*1515*) (Roell 1893). A form with short, obtuse leaves with the margins strongly revolute was also found at Yellowstone, as was var. *gracilescens* Schimper, sterile (*1508)* (Roell 1893). (As *Bryum pseudotriquetrum*) In all states and provinces of the Pacific Northwest: Alaska., Yuk., Cal., Nev., Colo.; widespread in the Middle West and from New England

to N. Carolina. Sand Creek, Albany Co. (*Nelson 7002*); Centennial, Albany Co. (*Nelson 1259*); Medicine Bow Mts., Albany County (*Nelson 7822*—see below), Porter (1935). (As *Bryum bimum* Schreb.) Laramie Peak, Albany County (*Nelson 7536*); Big Sandstone Creek, Carbon Co. (*Porter 914*), Porter (1935). (?)"Ferris Mountains, Carbon Co. (Nelson 4977). The determination is by Holz., and he has questioned its accuracy," Porter (1935). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Albany Co.: wet rocks, Sheep Mountain, 2 Sep 1903, *Goodding 2098*, det. Holz. (Plants of Wyoming, printed label) (RM, US); in spruce woods, Medicine Bow Mts, 30 Jul 1900, *Nelson 7822* in exsiccat Plants of Wyoming (RM). Fremont Co.: swampy border of Fiddler's Lake (Wyo. Rte.131), 9300 ft, 18 Jun 1973, *Hermann 25294* (RM). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Hwy; W side Beartooth Pass, under late snow patch on steep slope N of switchback, rills & snowbeds, 3200 m, 18 Aug 1973, *Weber B–44305* (COLO, RM). Sheridan Co.: wet ground, *Nelson 2416* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at south end of lake, 14 May 1989, *Andrus 7798* (BING). Teton Co.: 7000 ft, *Hermann 25574* (RM). Yellowstone Natl Park: Black Sand Basin, with *Hygrohypnum bestii*, *Lawton 1871* (WTU); Beartooth Plateau, Cook City to Red Lodge Highway,

alpine bogs of east summit, east slope, head of Wyoming Creek, 3250 m (as *B. pallens*), *Weber B–44224* (RM, COLO-redet. Spence).

This is supposed to be a West Coast species, with red capsules and leaves imbricate, i.e., barely contorted. (See note under *Bryum pallens*—the specimen of *Nelson 4977* at US was *B. pallens*.) One specimen of *Bryum pseudotriquetrum* s. lat. seen from RM had brown capsules and was synoicous, perhaps indicating that the dioicous-synoicous condition is variable. That specimen was *Nelson 7002* of Plants of Wyoming exsiccat, Holz. Det. Sand Creek, Albany Co., 1 Jun 1900, on the river banks under a cliff. The determination had a query.

Ptychostomum turbinatum (Hedw.) J.R. Spence, Phytologia 87: 22. 2005.
Mnium turbinatum Hedw., Sp. Musc. Frond. 191. 1801.
Bryum anceps Card. & Thér.
Bryum denticulatum Kindb. in Macoun
Bryum extenuatum Ren. & Card.
Bryum haematophyllum Kindb. in Macoun
Bryum turbinatum (Hedw.) Turner
Hypnum turbinatum (Hedw.) Web. & Mohr.

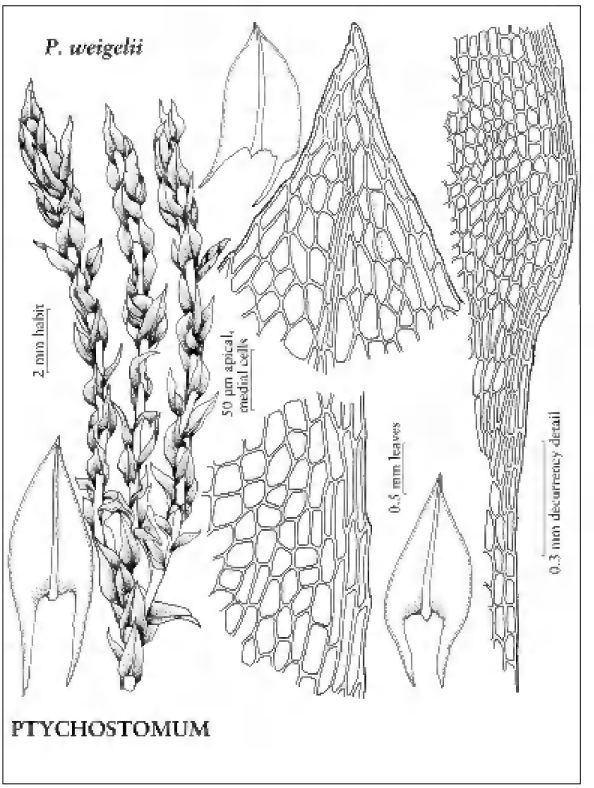
Wyoming (FNA, Vol. 28, 2014). (As *Bryum turbinatum*) B.C., Mont., Wyoming; Yuk., Nev., Utah, Colo.; Sask; reported from Idaho, Cal., Ariz. (As *Bryum turbinatum*) Tower Falls, Yellowstone Natl Park (collector unknown), Porter (1935). Teton Co., Spence (1985).

(All as *Bryum turbinatum*) Albany Co.: La Plata Mines, with *Leptobryum pyriforme, Mnium marginatum* (in packet of) and *Distichium capillaceum,* 25 Aug 1898, *Nelson 5176* (RM). Carbon Co.: Ferris Mts., Flora of Wyoming, 25 Jul 1898, *Nelson 4978* (NY, RM, US); same, *Nelson 4977* (as *Bryum crassirameum* R. & S. "?") (US, RM). Park Co.: Togwotee Pass, 9658 ft, 13 Aug 1953, *Lawton 1725*, c.fr., indehiscent (NY). Sublette Co.: alpine, moist area, 11,200 ft, *Rolston 85098* (CSU). Yellowstone Natl Park: Slough Creek, 1000 m, 22 Aug 1922, *Hawkins s.n.,* (NY); 2–7 Jul 1922, *Hawkins 538,* c.fr., (NY).

The Carbon Co. material *Nelson 4977* is beautiful—the cilia are poorly developed, the leaves not contorted, the cells lax, and the plants dioicous (male plants in the specimen with buds at the stem tips). It fruited 25 Jul 1898. The margins are recurved, but not consistently so to the apex—mostly appearing not recurved. The dioicous condition uis distinctive, as far as descriptions are concerned. The capsules are relatively short, the operculum not particularly small, and not zygomorphic—see discussion in Flowers (1973) who often found the capsules straight.

The distinction from *Bryum uliginosum* is apparently sexual (*Bryum uliginosum* is autoicous, small mouthed with a longer, long necked capsule). Also in *B. pallens*, according to Lawton (1971), the cilia are appendiculate, in *B. uliginosum* they are rudimentary. The *Nelson 4978* specimen has tiny male plants, that is, the antheridia were found with some effort. The plants are dioicous. This specimen is striking by the broad pyriform capsules. The leaves when dry are not contorted but erect and undulate, with leaves a dull yellow-green. The plant is striking by its erect leaf margins (not recurved) and the lax to firm-lax leaf cells. The stem is not rosulate. Note, however, the (to me) distinct leaf border which in older leaves is bistratose in parts in older leaves—this differs from all descriptions of this taxon (indistinct and unistratose) but Spence's. I found the peristome teeth yellow-brown and not very distinctive. *Bryum schleicheri* is said to be of the Pacific coast and coast ranges, with leaves that are shiny and erect. Since this specimen (*Nelson 4978*) is clearly in the interior I have concurred with the designation *B. turbinatum*.

Ptychostomum weigelii (Sprengel) J.R. Spence, Phytologia 87: 22. 2005.
Bryum weigelii Sprengel, Mant. Prim. Fl. Hal., 55. 1807.
Bryum duvalii Voit in Sturm
Bryum leucobasis Kindb.
Mnium duvalii (Voit) Schwaegr.



Courtesy FNA Association, FNA 28, 2014

Wyoming (FNA, Vol. 28, 2014). (As *Bryum weigelii*) B.C., Wash., Idaho, Mont., Wyoming; Alaska, Cal., Utah. Colo.; Mich., Ont.; Quebec, New Berun, Nova Scot., New Eng. (As *Bryum duvalii* Voit. in Sturm) Laramie Peak, Albany Co. (*Nelson 7553*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Bryum weigelii*) Carbon Co.: Medicine Bow Mountains, 8600 ft, *Hermann 26717* (RM); Laramie Peak, shaded stream banks, *Nelson 7553* in Plants of Wyoming, sterile (RM).

This species may look strikingly like a *Mnium* in etiolated forms of wet habitats. The stems are long, tangled and reclining to matted in appearance like some Mnia. It is separated from species in that genus by the toothless margins and the long decurrencies. As far as I know, there are no

toothless Mnia coupled with these long decurrencies. The apiculate apex of *B. weigelii*, in the upper leaves, is also diagnostic.

PYLAISIA Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 87, plate 455. 1851 (as Pylaisaea), name and orthography conserved. (Hypnaceae)
Pylaisiella Kindb. ex Grout

Pylaisia polyantha (Hedw.) Schimp. in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 88. 1851 (as Pylaisaea)
Leskea polyantha Hedw., Sp. Musc. Frond., 229. 1801.
Isothecium polyanthum (Hedw.) Spruce
Pterogonium polyanthos (Hedw.) Muhlenberg
Pylaisia cyrtophylla Kindb.
Pylaisia denticulata Schimper ex Sull.
Pylaisia filari-acuminata Müll. Hal. & Kindb.
Pylaisia jamesii Sull. & Lesq.
Pylaisia ontariensis Müll. Hal. & Kindb.
Pylaisia polyantha var. *jamesii* (Sullivant & Lesq.) Rau & Hervey
Pylaisia polyantha var. *subdenticulata* (Schimper) Rau & Hervey
Pylaisia pseudoplatygyrium Kindb.
Pylaisia subdenticulata Schimper
Pylaisia suttonii Jennings
Pylaisiella polyantha (Hedw.) Grout
Pylaisiella subdenticulata (Schimper) Grout
Stereodon polyanthos (Hedw.) Mitt.
Stereodon subdenticulatus (Schimper) Mitt.

Not listed for Wyoming in FNA (FNA, Vol. 28, 2014). (As *Pylaisiella polyantha* var. *pseudoplatygyria* (Kindb.) Grout. Hawk's Ranch, Colorado- Wyoming State line, Albany County (*Williams 100*), Porter (1935). A sterile and unidentifiable specimen of *Pylaisiella* (as *Pylaisia*) was collected in Yellowstone Natl Park by Roell (1893), specimen number *1533*.

Pylaisiella polyantha (Hedw.) Grout = Pylaisiella polyantha (Hedw.) Schimp. in P. Bruch and W. P. Schimper

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RACOMITRIUM Brid., Muscol. Recent., suppl. 4: 78. 1818. (Grimmiaceae)
Grimmia sect. Racomitrium (Brid.) Müll. Hal.
Racomitrium sect. Lanuginosa (Kindb.) Noguchi
Rhacomitrium Lorentz, orthographic variant
Trichostomum sect. Racomitrium (Brid.) Duby

Racomitrium canescens (Hedw.) Brid. = Niphotrichum canescens (Hedw.) Bed.-Ochyra & Ochyra in R. Ochyra et al.

Racomitrium canescens (Hedw.) Brid. var. ericoides (Brid.) Hampe = Niphotrichum ericoides (Brid.) Bed.-Ochyra & Ochyra in R. Ochyra et al.

Racomitrium fasciculare (Hedw.) Brid. = Codriophorus fascicularis (Hedw.) Bed.-Ochyra & Ochyra in R. Ochyra et al.

Racomitrium heterostichum var. macounii (Kindb. in Macoun) G. Jones in Grout = Bucklandiella macounii (Kindb. in Macoun) Bed.-Ochyra & Ochyra in R. Ochyra et al.

Racomitrium heterostichum var. sudeticum (Funck) Bauer = Racomitrium sudeticum (Funck) P. Bruch & Schimp. in B.S.G. = Bucklandiella sudetica (Funck) Bed.-Ochyra & Ochyra in R. Ochyra et al.

[*Racomitrium lanuginosum* (Hedw.) Brid., Muscol. Recent., suppl. 4: 79. 1818 (Grimmiaceae)]
Trichostomum lanuginosum Hedw., Frond., 107. 1801.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007) where the species is reported from regions north of the Wyoming area.

Wyoming: Yellowstone Natl Park (*1473, 1474*), Lower Geyser (*1475*) (Roell 1893; Crum & Anderson 1981).

Racomitrium sudeticum (Funck) P. Bruch & Schimp. in B.S.G. = Bucklandiella sudetica (Funck) Bed.-Ochyra & Ochyra in R. Ochyra et al.

RHIZOMNIUM (Mitt. ex Broth.) T. Kop., Ann. Bot. Fenn. 5: 142. 1968. (Mniaceae)
Mnium sect. Rhizomnium Mitt. ex Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 219(I,3): 612. 1904.

In Park Co., *Elodium blandowii,* forms a rich bryophyte community combined with *Aulacomnium palustre*, *Climacium dendroides*, *Hylocomium splendens, Helodium blandowii, Rhizomnium* spp., *Marchantia alpestris*, (*Thuidium recognitum*, q.v.) and others," Kosovich-Anderson & Weber (2011).

Rhizomnium andrewsianum (Steere) T. Kop.., Ann. Bot. Fenn. 5: 143. 1968.
Mnium andrewsianum Steere, Bryologist 61: 175, figs. 1–12. 1958.

Not reported for Wyoming in FNA, its habitat and distribution given in FNA are "Wet areas (depressions) in tundra; low elevations; Greenland; Alta., Nfld. and Labr., N.W.T., Nunavut, Yukon; Alaska; Europe; Asia" (McIntosh & Newmaster, FNA Vol. 28, 2014). Note that this species is not recorded for Colorado by Weber and Wittmann (2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway; swales around small lakes, 2900 m, subalpine zone between Long Lake and lower Sheepherder Lakes, 19 Aug 1973, *Weber B–44267* (RM, COLO).

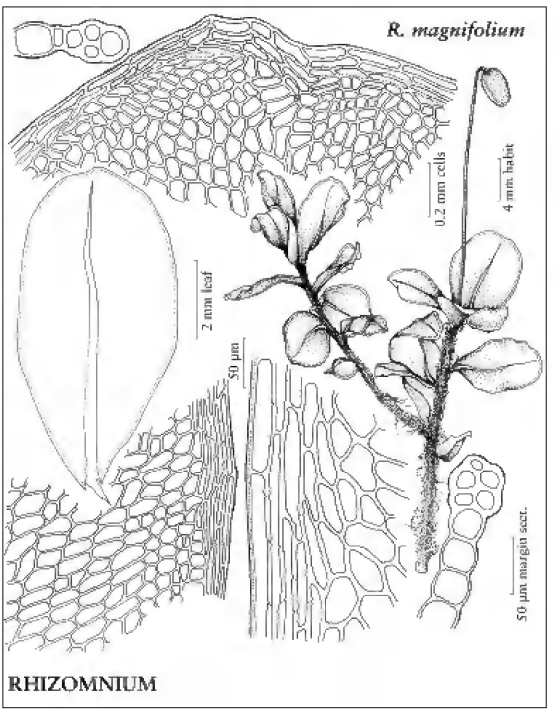
Although the specimen was sterile the leaf dimensions correspond with the description in Lawton (1971), the costa was decidedly below the apex of the leaf, more than in *M. pseudopunctatum*, and the leaves were more evidently crisped, whereas in *M. pseudopunctatum* they lie flat and are crisped more around the edges. The specimen from Park Co. was so crisped that the plants looked small in striking contrast to typical broadly expanded *M. pseudopunctatum*. The subalpine zone station also approximates the habitat noted for *M. andrewsianum*.

Rhizomnium magnifolium (Horikawa) T. Kop., Ann. Bot. Fenn. 10: 14. 1973.
Mnium magnifolium Horikawa, J. Jap. Bot. 11: 503, figs. 4, 5. 1935.
Mnium punctatum var. *elatum* Schimp.
Rhizomnium magnifolium (Horik.) T. Kop.
Rhizomnium perssonii T. Kop.

Wyoming (FNA Vol. 28, 2014). (As *Rhizomnium perssonii* Koponen) Lawton (1971). Albany County, Carbon County, and Teton County, Porter (1935). (As *Rhizomnium magnifolium* (Horik.) T. Kop.) Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: *Sturges 247* (RM); 10,600 ft, *Lichvar 1331* (RM); Medicine Bow Mountains, 10,000 ft, *Hermann 17697* (RM). Bighorn Co.: T50N, R 86 W, Sect. 4, 10,000–10,400 ft, *Odasz 743* (RM). Park Co.: 7500 ft, *Hermann 20058* (RM). Teton Co.: Teton Range, 7000 ft, *Hermann 25580* (RM). Yellowstone Natl Park: 7 Jul 1934, *Frye s.n.* (RM).

In the *Odasz 743* specimen, the costae ended well below the apex, mostly forked, but with several leaves percurrent or subpercurrent. The laminal cells were weakly (not strongly) collenchymatous, and also weakly (not strongly) pitted. The marginal border was 2-stratose (which *R. pseudopunctatum* never is according to McIntosh and Newmaster FNA Vol. 28, 2014). The illustration of *R. punctatum* by Crum and Anderston (1981) shows a strong apical border of several rows of cells, even in small forms. The apex of *Mnium punctatum* var. *elatum* (= *R. magnifolium*) shows a single row of elongate marginal cells at the apex which seems in keeping with the abbreviated costa. The apex is also often notched (emarginate) in leaves with subpercurrent costae. The laminal cells near the leaf margins are very much smaller than those toward the costa, many isodiametric (not elongate-rectangular). The leaf bases are broadly decurrent or sometimes the leaf margins end nearly against or flush with the base of the costa.



Courtesy FNA Association, FNA 28, 2014

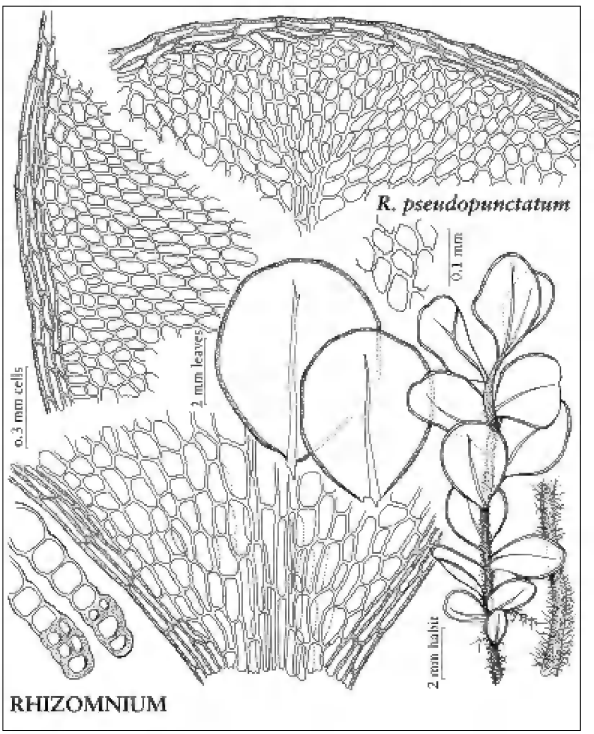
Rhizomnium pseudopunctatum (P. Bruch & W.P. Schimper) T. Kop., Ann. Bot. Fenn. 5: 143. 1968.
Mnium pseudopunctatum Bruch & Schimp, London J. Bot. 2: 669. 1843.
Mnium subglobosum B.S.G.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Centennial Hills, 20 Aug 1896, *Nelson 2702* (RM); Centennial Valley, 19 Aug 1895, *Nelson 1744* (RM). Carbon Co.: Medicine Bow Mts., 9000 ft, moss-covered, peaty bank of Trail Creek, W of Sand Lake Rd., 4 1/2 mi SW of Morgan, *Hermann 17799* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May1989, *Andrus 7797* (BING).

Rhizomnium punctatum (Hedw.) T. Kop., Ann. Bot. Fenn. 5: 143. 1968.
Mnium punctatum Hedw., Musc. Frond. 193. 1801.
Rhizomnium punctatum subsp. *chlorophyllosum* (Kindb.) T. Kop.

Wyoming (FNA 28, 2014). (Carbon, Teton cos.), Yellowstone Natl Park, Porter (1935). (As *Rhizomnium punctatum* (Hedw.) T. Kop.) Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

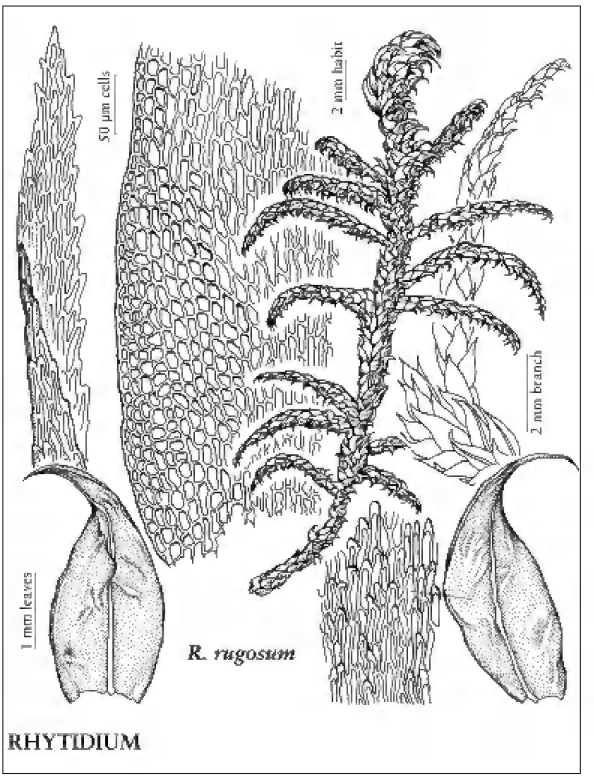
RHYTIDIADELPHUS (Limpr.) Warnst., Krypt.-Fl. Brandenburg 2: 917. 1906. (Hylocomiaceae)
Hylocomium subg. *Rhytidiadelphus* Limpr., Laubm. Deutschl. 3: 590. 1901.
Hylocomiadelphus Ochyra & Stebel

Rhytidiadelphus triquetrus (Hedw.) Warnst., Krypt.-Fl. Brandenburg 2: 920. 1906.
Hypnum triquetrum Hedw., Sp. Musc. Frond., 256. 1801.
Rhytidiadelphus triquetrus var. *beringianus* (Card. & Thériot) Grout

Wyoming (FNA Vol. 28, 2014). Yellowstone Natl Park (*Smiy*, *Harris, and Porter*), Porter (1935).

Yellowstone Natl Park: 21 Aug 1938, *Bartley & Pontious s.n.* (RM); *Harris 219* (RM); 6 Jul 1934, *Frye s.n.* (RM).

RHYTIDIUM (Sull.) Kindb., Bih. Kongl. Svensk. Vetensk.-Akad. Handl. 6: 8. 1882. (Rhytidiaceae)
Hypnum sect. Rhytidium Sull. in A. Gray, Manual ed. 2, 675. 1856.



Courtesy FNA Association, FNA 28, 2014

Rhytidium rugosum (Hedw.) Kindb., Bih. Kongl. Svenska Vetensk.-Akad. Handl. 7(9): 15. 1883.
Hypnum rugosum Hedw., Sp. Musc. Frond., 293. 1801.

Hylocomium rugosum (Hedw.) De Not.

Wyoming, "Though widespread, *Rhytidium rugosum* is infrequent, presumably because of a preference for exposed calcareous or mafic bedrock in a cool habitat" (Rohrer, FNA Vol. 28, 2014). Hawk's Ranch, Colorado-Wyoming State line, Albany County (*Porter 1445*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: road from Bear Tooth Lodge to Red Lodge, near summit at 10,940 ft, 21 Aug 1953, *Lawton 1981* (WTU).

Roellia roellii (Broth. in Roell) Andrews in Crum = Roellobryon roellii (Broth.) Ochyra

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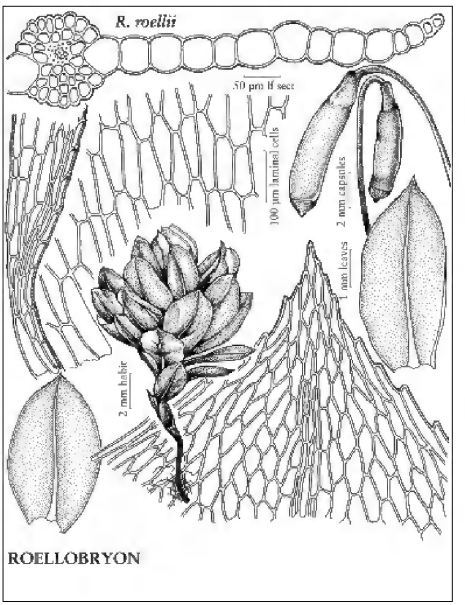
ROELLOBRYON Ochyra, Polish Bot. J. 56: 119. 2011. (Invalid genus name *Roellia* and Greek *bryon*, moss, to coin a valid name for the genus). (Roellobryaceae)
Roellia Kindb., Gen. Eur. N.-Amer. Bryin., 37. 1897, not *Roella* Linnaeus 1753.

Roellobryon roellii (Broth.) Ochyra, Polish Bot. J. 56: 119. 2011.
Mnium roellii Broth., Bot. Centralbl. 44: 420. 1890.
Bryum lucidum Britt.
Bryum sandbergii Holz.
Bryum simplex Kindb. in Macoun
Mnium lucidum (E. Britton) Broth.
Mnium simplex (Kindb.) Kindb.
Roellia lucida Kindb.
Roellia roellii (Broth.) Andrews in Crum
Roellia simplex Kindb.



Courtesy FNA Association, FNA 28, 2014

Wyoming; "*Roellobryon roellii* is rare in Alaska, Nevada, and Utah, and is most common in areas south of the Pleistocene ice-sheets in western North America. Coastal Alaskan-northern British Columbia populations probably survived glaciation in refugia. The species has been found near sea level in coastal Alaska but generally occurs at 500–3200 m" (Spence, FNA Vol. 28, 2014). In all states and provinces of the Pacific North West.; Cal. Colo. (As *Bryum lucidum*) Carbon, Teton cos., Porter (1937). (As *Roellia roellii*) Teton Co., Spence (1985). Vitt (1993, gives the same Wyoming distribution with no citation of specimens.

Teton Co.: Teton Natl Park, Cascade Trail, 14 Aug 1953, *Lawton, 1749*, c.fr. (WTU); Cascade Canyon, 19 Aug 1935 , *Ownbey s.n.* (WTU). Yellowstone Natl Park: on ground in woods, Lower Falls of Yellowstone River, *Bartley & Pontious 4* (RM).

ROSULABRYUM J.R. Spence, Bryologist 99: 222. 1996. (Bryaceae)

[*Rosulabryum canariense* (Brid.) Ochyra, Biodivers. Poland 3: 162. 2003, excluded.]
Bryum canariense Brid., Muscol. Recent., suppl. 3: 29. 1817.
Bryum hendersonii Ren. & Card.
Bryum provinciale Philib. in Schimp.

Not reported from Wyoming by FNA; "Moist soil banks, soil over rock; low to high elevations (0–1600 m); B.C.; Calif., Oreg., Wash. (Spence, FNA Vol. 28, 2014). British Columbia, Washington, Oregon; California. (As *Bryum provinciale* Philib.) Medicine Bow Mts., Albany County (*Nelson 7814*), Porter (1935).

Examination of the *Nelson 7814* collection at RM and US shows this is *Bryum caespiticium* Hedw. The geographic anomaly is striking, but more particularly the Nelson specimen had long awns in fertile stems, was not rosulate in stem leaf arrangement, and it had strongly developed cilia that were clearly appendiculate. Sterile stems of this species approximate *B. canariense* in their short, reflexed mucros and the numerous tiny innovative branches that may serve as propagules. No tubers were seen. The propagulaceous tiny stems (not often described for *B. caespiticium*) seem to have confused early workers in the western flora with bulbils (cf. *B. dichotomum*). Leaves "large with short recurved hairpoint, often in 2 or more interrupted comal tufts along stem; leaf border weak or lacking at apex; tubers brown" (Spence,1988). Spence also says "predominantly coastal Mediterranean climates: British Columbia, Washington, Oregon, California. "*Bryum canariense* is dioicous and lacks tubers, while *B. provinciale* is autoicous or synoicous and produces rhizoidal tubers. Some gatherings from western North America are dioicous and produce tubers, hence I prefer to regard *B. provinciale* as a variety of *B. canariense*."

Rosulabryum capillare (Hedw.) J.R. Spence, Bryologist 99: 223. 1996.
Bryum capillare Hedw., Sp. Musc. Frond. 182. 1801.
Bryum capillare ssp. *heteroneuron* Müll. Hall. & Kindb. in Macoun
Bryum oreganum Sull.
Mielichhoferia cuspidifera Kindb. in Macoun

Wyoming (FNA Vol. 28, 2014). (As *Bryum capillare*) Wyoming: Yellowstone Natl Park (1517 fo. *sterilis*, ad var. *carinthiacum* vergens (Roell 1893). (All as *Bryum capillare)* B.C., Wash., Ore., Ida., Mont., Wyoming; Cal. Nev., Ariz; widspread in the Middle W and in eastern N. Amer from Quebec to Fla. (As *Bryum oreganum* Sulliv.) Centennial, Albany Co. (*Nelson 2707*, in part & *2708*); Dome Lake, Sheridan Co. (*Nelson 8826*), Porter (1935). (As *Bryum capillare*) Antelope Basin, Albany County (*Nelson 7484*); Loomi Creek, Natrona Co. (*Goodding 180*), Porter (1935). (As *Bryum capillare* ssp. *herpetoneuron*) Albany, Natrona Cos., Porter (1937). Teton Co., Spence (1985). Campbell Co., Medina (1994). (As *Bryum torquescens*) Druid Peak (*Nelson 5801*); and

Norris (*Smiy*), both in Yellowstone Natl Park, Porter (1935). See discussion in Crum and Anderson (1981: 574). The *5801* specimen of Nelson at Druid Peak I have redetermined as *Bryum lisae* var. *cuspidatum* (q.v.).

(All as *Bryum capillare)* Albany Co.: Antelope Basin, Damp woods, 9 Jul 1900, *Nelson 7484* (Holz. exsiccat), deoperculate (RM & US). Natrona Co.: Big Horn Mts., First Water Creek, dry creek bed and road crossing, 7700 ft, 1 Aug 1979, *Hartman 10452*, c.fr,. operculate, with *Funaria hygrometrica* (BUF, RM). Natrona Co.: Moist places under a ledge, Loomi Creek, 3 Jul 1901, *Goodding 180*, det. Holz., Plants of Wyoming 180, c.fr., operculate (US). Sheridan Co.: Dome Lake, 16 Jul 1896, *Nelson 8826,* c.fr., with *Drepanocladus uncinatus* & *Philonotis fontana* var. *fontana* (RM). Teton Co.: Lower Slide Lake, growing along a intermittant stream on dark sandy soil, common, 7000 ft, *25* May 1977, *Lichvar 115*, c. deoperculate fruit (old) (RM). Washakie Co.: Big Horn Mtns., along Red Fork Powder River, 7300 ft, river bank, 11 Jul 1979, *Nelson 3556*, operculated (BUF, RM).

Most descriptions of this species emphasize the sterile plants. Characteristics of the fruiting stems are leaves that are much like *Bryum lisae* var. *cuspidatum*, only very thin (lax) walled. The Washakie Co. specimen was synoicous, the antheridia relatively large (larger than what I have been calling *Bryum lisae* var. *cuspidatum*). The plants can form polsters or cushions: *B. lisae* does not, that I know of. The sterile stems with percurrent but generally not long-excurrent costae are more diagnostic than the fruiting stems. Collections with a lot of fertile stems have long awns (Teton Co.). The Washakie Co. specimen had two setae coming from one archegonium, plus antheridia! The Teton specimen also was synoicous with strikingly large archegonia.

[*Rosulabryum flaccidum* (Brid.) J.R. Spence, Phytologia 89: 114. 2007, excluded.]
Bryum flaccidum Brid., Bryol. Univ. 1: 667("665"). 1826.

Not reported for Wyoming by FNA although noted in Colorado and Nevado and so to be expected (FNA Vol. 28, 2014)

"In North America there has been significant confusion over the identity of the small species that produce filiform gemmae in the leaf axils. H. Syed (1973) named the common widespread species with short, rosulate innovations *Rosulabryum flaccidum*, and described a new species, *R. laevifilum*, for specimens with smooth gemmae. However, these two species completely intergrade, and the name *R. flaccidum* was incorrectly applied. The correct name is thus *R. laevifilum* for what has passed as *R. flaccidum* in North America. True *R. flaccidum* is a very different species related to *R. pseudocapillare*, with a type from Hispaniola" (Spence in FNA Vol. 28, 2014).)

Rosulabryum laevifilum (Syed) Ochyra, Biodivers. Poland 3: 162. 2003.
Bryum laevifilum Syed, J. Bryol. 7: 293, figs. 13, 14. 1973.

Wyoming (FNA Vol. 28, 2014).

"*Rosulabryum laevifilum* is the (North American) flora's most widespread species of the genus with filiform gemmae, and is the most common corticolous species. The sporophytes are rare. Specimens on bark are often very small compared with those on other substrates. See also the discussion under *R. flaccidum*" (Spence in FNA Vol. 28, 2014).

[*Rosulabryum torquescens* (Bruch ex De Not.) J.R. Spence, Bryologist 99: 223. 1996, excluded]
Bryum torquescens Bruch ex De Not., Syllab. Musc., 163. 1838
Bryum capillare subsp. *torquescens* (Bruch ex De Not.) Kindb.

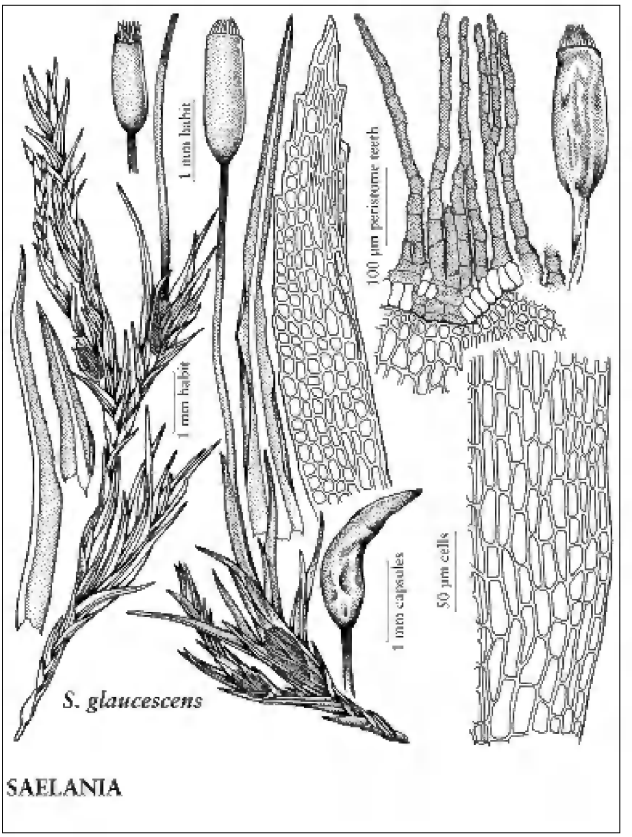
Not known for Wyoming in FNA, but to be looked for. Reported for Nevada (FNA Vol. 28, 2014).

SAELANIA Lindb., Utkast Eur. Bladmoss., 35. 1878. (Ditrichaceae)

Saelania glaucescens Hedw.) Broth. in J. O. Bomansson and V. F. Broth., Herb. Mus. Fenn., Musci, 53. 1894.
Trichostomum glaucescens Hedw., Sp. Musc. Frond., 112. 1801.
Ditrichum glaucescens (Hedw.) Hampe
Saelania caesia (P.-Beauv.) Lindb.

Wyoming by FNA (FNA Vol. 27, 2007). British Columbia, Alberta, Wyoming; Alaska, Yukon, Colorado, Arizona; Manitoba, Minnesota, Iowa; Ontario, Greenland and Nova Scotia south to New Jersey. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: W of Bear Tooth Butte, Crazy Creek campground, 22 Aug 1953, *Lawton 2020*, old fruit (WTU).



Courtesy FNA Association, FNA 27, 2007

SANIONIA Loeske, Hedwigia 46: 309. 1907. (Amblystegiaceae)

[*Sanionia georgico-uncinata* (C. Muller) R. Ochyra & L. Hedenäs in R. Ochyra, excluded.]

This species has been excluded from North America (Hedenäs 2011); the name to be used for North American species formerly under this name is instead *Sanionia nivalis* Hedenäs.

Sanionia nivalis Hedenäs, Ann. Bot. Fenn. 26: 411, figs. 10–12. 1989.

Wyoming (FNA Vol. 28, 2014).

Park Co.: Shoshone Natl. For., Beartooth Plateau; alpine fen in small depression beside the head of Natl Forest Trail #623, 100–150 m E of Beartooth Scenic Byway, on wet peaty soil, locally abundant, 44°58.770–775'N, 109°25.530–540' W, ca. 10,700 ft (3260 m), 19 Aug 2008, *Kosovich-Anderson 3430* (COLO, MO, S). Park Co.: unnamed tributary of Frozen Lake, seepage slope, on soaked peaty soil and wet clay along streamlets, snow melt area, in pure mats and assoc. with *Polytrichastrum sexangulare, Polytrichum juniperinum, and Brachythecium brandegeei*, 44°58.050–060'N, 109°28.870–890'W, ca. 10,500 ft (3200 m), 14 Aug 2008, *Kosovich-Anderson 2626A* (MO). Other Park Co. specimens are cited also without herbarium designation; see citations in Kosovich-Anderson & Weber (2011). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Hedenäs (2011) reported that *Sanionia georgico-uncinata* and *S. nivalis* are morphologically indistinguishable and are separated by molecular information, the former belongs to the Southern Hemisphere, the latter to the Northern.

Sanionia uncinata (Hedw.) Loeske, Hedwigia 46: 309. 1907
Hypnum uncinatum Hedw., Sp. Musc. Frond., 289. 1801.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus uncinatus var. *plumosus* (Schimp.) Warnst.
Drepanocladus uncinatus var. *subjulaceus* (Schimp. in B.S.G.) Warnst.
Hypnum uncinatum subsp. *moseri* (Kindb.) Kindb.

Wyoming (FNA Vol. 28, 2014). (As *Hypnum uncinatum* Hedw.) Wyoming: Yellowstone Natl Park (*1570–74*) (Roell 1893). (All as *Drepanocladus uncinatus* (Hedw.) Warnst.) Albany County, Big Horn County, Carbon County, Teton County, and Yellowstone Natl Park. "The following varieties have been recorded: var. *auriculatus, plumosus* and *symmetricus*," Porter (1935). Albany, Big Horn, Carbon, Fremont, Johnson, Teton cos., Yellowstone Natl Park, Porter (1937). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Medicine Bow Mtns., Medicine Bow Natl Forest, Barber Lake Picnic Area 2.5 mi NW of Centennial, 2660 m, *Pinus contorta* forest along Libby Creek, *Buck 23195* (NY); on leaf mold in woods 1 1/4 mi S of Brooklyn Lake, 10,000 ft, Medicine Bow Mts., 9 mi W of Centennial, 3 Aug 1962, *Hermann 17693* (RM). Carbon Co.: on a rotten log, Battle Creek Canyon, 7000 ft, 26 Jun 1934, *Porter 1736* (RM). Fremont Co.: on moderately dry soil and humus, Brooks Lake, To-Gwo-Tee Pass, 15 Aug 1934, *Porter 1614* (RM). Park Co.: 3250 m, *Weber B–44265* (COLO, RM); Beartooth Plateau, Cooke City to Red Lodge Highway, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, 19 Aug 1973,*Weber B–44276* (COLO, RM); basaltic sand, 6000 ft, 1 Apr 1988, *Vukelich s.n.,* det. Crum (BUF); wet marly substrate, in calcareous fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1725* (BUF). (With *Hygrohypnum styriacum* specimen, q.v.) Beartooth Lake, W and SW shore, *Picea engelmannii* forest along the shore, on wet clay, 44°56.500–520'N, 109°35.980–990'W,

ca. 8,900 ft (2700 m), 24 Jul 2010, *Kosovich-Anderson 6652* (no herb. cited). Sheridan Co.: (as var. *uncinatus*) conifer litter over mineral soil in spruce/fir forest, Big Horn Natl Forest, T57N, R89W, Section 34, 19 Jun 1992, *McKee 92-F2*, with *Tortula ruraliformi* (RM); in packet of *Bryum capillare*, with *Philonotis fontana* var. *fontana*, Dome Lake, 16 Jul 1896 (RM). Sublette Co.: Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 10,290 ft , 42°59'N, 109°34'W, along small stream, on rocks, 16 May1989, *Andrus 7840* (BING); Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189; wooded spruce bank, sandstone rocks, lush herbage, N slope, Hoback River valley, shaded sandstone rock, with *Brachythecium salebrosum,* 5 Jul 1985 *Eckel 9612516* (BUF, RM). Teton Co.: On US26 & US237, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis* wood-land, xeric but for stream bottoms, 6 Jul 1985, *Eckel 9408200*. (BUF). Yellowstone Natl Park: in the spray of the falls, Tower Falls, *Nelson & Nelson 5911,* exsiccat Plants of Yellowstone Natl. Park, det. Holz (RM).

There is a var. *symmetrica* (Ren. & Card.) Crum & Anderson in the 1990 checklist, which is accepted as *Sanionia symmetrica* (Ren. & Card.) Wheldon (FNA Vol. 28, 2014). It is a western taxon to be looked for in Wyoming—capsules are needed for identification.

SARMENTYPNUM Tuomikoski & T. Kop., Ann. Bot. Fenn. 16: 223. 1979. (Calliergonaceae)

Sarmentypnum exannulatum (Schimper) Hedenäs, J. Hattori Bot. Lab. 100: 132. 2006.

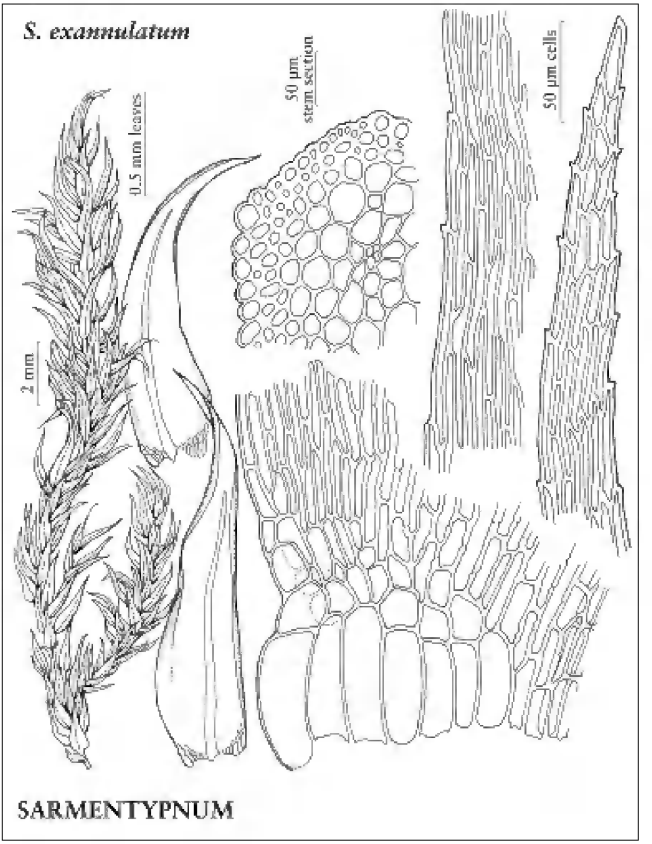
Hypnum exannulatum Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 110, plate 603. 1854.
Drepanocladus exannulatus (Schimper) Warnst.
Drepanocladus exannulatus var. *alpinus* (Grav.) Wijk & Marg.
Drepanocladus exannulatus var. *brachydictyon* (Ren.) G. Roth
Drepanocladus exannulatus var. *falcifolius* (Ren.) Grout.
Drepanocladus exannulatus var. *purpurascens* (Schimper) Herzog
Drepanocladus exannulatus var. *rotae* (De Not.) Loeske
Warnstorfia exannulata (Schimper) Loeske
Warnstorfia exannulata var. *purpurascens* (Schimper) Tuomikoski & T. Kop.

Wyoming (FNA Vol. 28, 2014). Johnson Co. (as *Warnstorfia exannulata*), in association with *Warnstorfia tundrae* (Lenz 2006). Park Co.: *Sarmentypnum exannulatum* was reported growing with *Plagiomnium ellipticum, Polytrichum juniperimum, Sarmentypnum sarmentosum and Sanionia nivalis,* Kosovich-Anderson & Weber (2011). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Drepanocladus exannulatus* (B.S.G.) Warnst. var. *exannulatus*): Teton Co., Spence (1985). Sublette Co. "species occupying peatland expanses and spring fens ... tolerant of long periods of saturation and submersion," Cooper & Andrus (1994). Var. *typicus* Grand Teton Nat. Park *3765* (NY) Wynne, (1944).

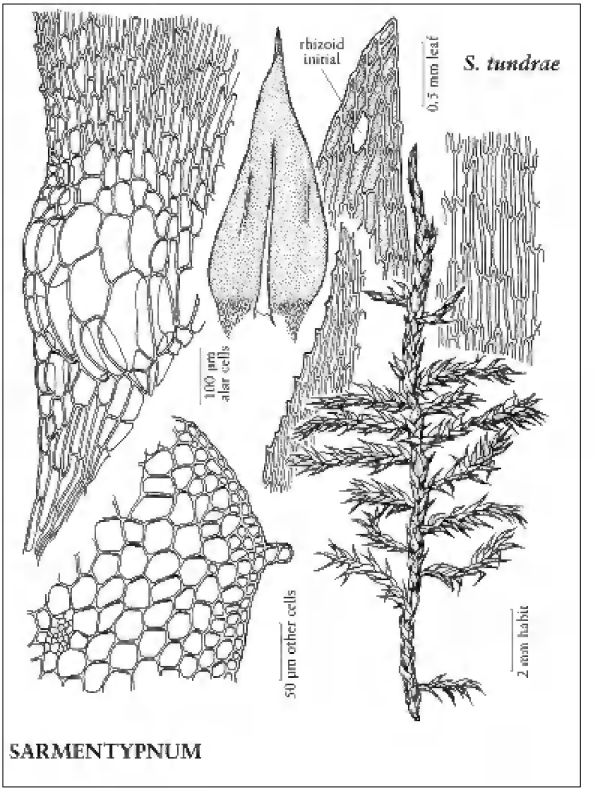
Albany Co.: 10,800 ft, *Rolston 86090* (CSU); La Plata Mines, 30 Aug 1898, *Nelson 5262* (RM); northW base of Sheep Mtn., along WY Rte. 11, ca. 4 mi due ESE of Centennial, ca. 7750 ft, fen with low forest, open area of bog, 4 Jun 1993, *Reese 18174* with *Bryum pseudotriquestrum, Cratoneuron filicinum* (LAF). Big Horn Co.: Big Horn Natl Forest, Lake Solitude Quadrant, Cloud Peak Wilderness area, T50N R86W, Sect. 7, 9720 ft streamside below Elk Mountain, 5 Aug 1992, *Zacharkevics s.n.* (BING). Carbon Co.: 9200 ft, *Porter 9698* (RM); Sierra Madre Range, 9600 ft, wet area by stream, *Kastning-Culp 754* (BUF, RM); emergent in pool in marsh near North French Creek at logging road crossing, 8600 ft, Medicine Bow Mountains, 6 mi E of Ryan Park, 27 Aug 1975,

Hermann 26718 (RM). Park Co.: 3200 m, *Weber B- 44310* (COLO, RM); wet soil in white spruce fen at base of Cathedral Cliff, 2 mi E of Crandall Ranger Station, 6600 ft, 19 Apr 1992, *Elliott 1929* (BUF). Sublette Co.: 11,200 ft, *Rolston 85109* (CSU).



Courtesy FNA Association, FNA 28, 2014

(All as var. *rotae* (De Not.) Loesk.) "Leaves more widely spaced and costa shortly to long filiform excurrent" Flowers (1973: 502). Albany Co.: Medicine Bow Mts., Silver Lake, growing 1/2 mi N of lake in a bog, abundant, 10,000 ft, 18 Sep 1977, *Lichvar 1335,* specimen with large, distinct auricles to costa, long, filiform apices, leaves distant on stem (RM). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1/4 mi SW of Barnes Lake, 9780 ft , 42°59'N, 109°36'W, pothole fen, 15 May 1989, *Andrus 7807* (BING). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Hwy, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, in shallow water of small lakes, 19 Aug 1973, *Weber B–44252* (originally id'd as *D. trichophyllus*) (RM, COLO).



Courtesy FNA Association, FNA 28, 2014

Sarmenthypnum sarmentosum (Wahlenberg) Tuomikoski & T. Kop., Ann. Bot. Fenn. 16: 223. 1979.
Hypnum sarmentosum Wahlenberg, Fl. Lapp., 380. 1812.
Calliergon sarmentosum (Wahlenb.) Kindb.
Calliergon sarmentosum fo. *heterophyllum* Arnell & C. Jens.
Calliergon sarmentosum fo. *homophyllum* Arnell & C. Jens.
Calliergon sarmentosum var. *beringianum* (Card. & Thér.) Grout
Calliergon sarmentosum var. *crispum* Karcz.
Calliergon sarmentosum var. *fallaciosum* (Milde) G. Roth
Calliergon sarmentosum var. *flagellare* Karcz.
Calliergon sarmentosum var. *fontinaloides* (Berggr.) G. Roth
Calliergon sarmentosum var. *subpinnatum* Warnst.
Warnstorfia sarmentosa (Wahlenberg) Hedenäs

Wyoming (FNA 28, 2014). Park Co.: *Sarmentypnum sarmentosum* was reported growing with *Plagiomnium ellipticum, Polytrichum juniperinum, Sarmentypnum exannulatum and Sanionia nivalis* (Kosovich-Anderson & Weber 2011). Teton Co., Spence (1985). Sublette Co., "species occupying peatland expanses and spring fens ... tolerant of long periods of saturation and

submersion," Cooper and Andrus (1994). Cited for Wyoming by Crum and Anderson (1981; 1998). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: 3250 m, *Weber B–44254* (RM, COLO). Sublette Co.: Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 10,290 ft, 42°59'N, 109°34'W, in small fen, 16 May 1989, *Andrus 7828* (BING).

Sarmentypnum tundrae (Arnell) Hedenäs, J. Hattori Bot. Lab. 100: 133. 2006.
Amblystegium tundrae Arnell, Kongl. Svenska Vetensk. Acad. Handl., n.s. 23(10): 128. 1890.
Drepanocladus exannulatus var. *tundrae* (Arnell) Warnstorf
Drepanocladus tundrae (Arnell) Loeske
Warnstorfia tundrae (Arnell) Loeske

Wyoming (FNA Vol. 28, 2014).

SCHISTIDIUM P. Bruch & W.P. Schimper, Bryol. Europ. 3: 93. 1845, name conserved. (Grimmiaceae)

Schistidium agassizii Sull. & Lesq., Musc. Hepat. U.S., 104. 1856.
Grimmia agassizii (Sull. & Lesq.) Jaeger & Sauerb.
Grimmia alpicola Hedw.
Grimmia alpicola var. *angusta* (I. Hag.) Mönk.
Schistidium agassizii Sull. & Lesq. in Sull.
Schistidium angustum I. Hag.
Schistidium lineare Limpr.

Wyoming (FNA Vol. 27, 2007). B.C., Oregon, Alberta, Idaho, Mont., Wyoming; Alaska, NorthW Territory, Cal., Colo.; Michigan, Ontario; New Brunswick, Quebec Maine, New York. Carbon Co.: inlet to Lake Marie, Medicine Bow Mts. (Hermann 17147), Robinson and Herman (1964). Teton Co., Spence (1985).

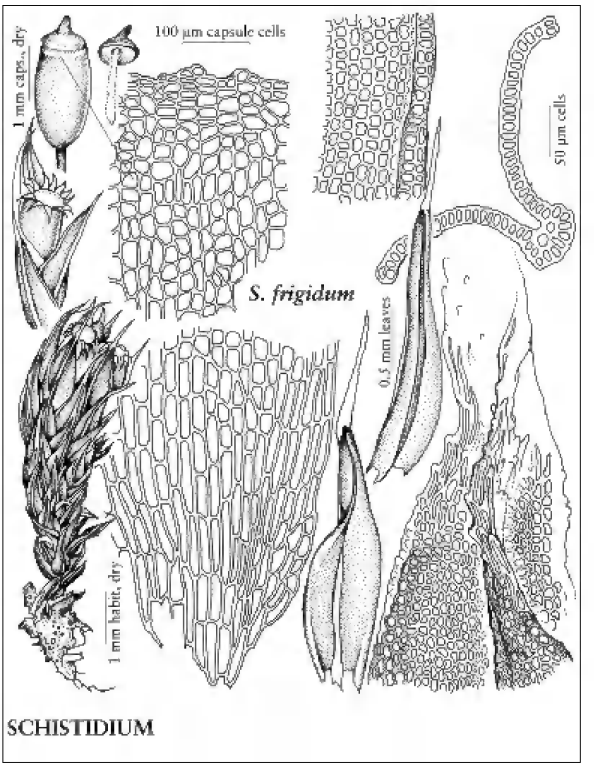
Carbon Co.: 10,000 ft, *Hermann 17147* (RM).

[*Schistidium apocarpum* (Hedw.) P. Bruch & W.P. Schimper, Bryol. Europ. 3: 99. 1845, excluded.]
Grimmia apocarpa Hedw., Sp. Musc. Frond., 76. 180.1
Schistidium lancifolium H.H. Blom
Schistidium umbrosum (J.E. Zett.) H.H. Blom
(For much additional synonymy see Eckel 1996).

Not reported for Wyoming in FNA (Vol. 27, 2007). There is some controversy whether this species occurs only in the eastern United States or has a more widespread distribution. For now it is reported here as excluded from Wyoming (McIntosh in Vol. 27. 2007). The species is not reported for Wyoming and appears to be absent from central Canada and the United States. It appears to occur north of the boundary with Canada, except in the Great Lakes area and Washington State (FNA Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Due to the recent extensive revisions of nomenclature, the following information is conjectural:

In all states and prov. of the Pacific Northwest; Alaska, Cal., Nev., Ariz., New Mex; widespread in central and eastern North America. Old Faithful, Yellowstone Natl Park (*Smiy*), Porter (1937). B.C., Wash., Oregon, Idaho, Mont., Wyoming; Michigan, Ont., Quebec, New York, Wyoming, Flowers (1973). Little Goose, Creek, Sheridan County (*Nelson 2416*, in part), Porter (1935). (As *Grimmia atricha* Müll. Hall. & Kindb. in Macoun & Kindb., Cat. Canad. Pl. 6: 65. 1892.) (As *Schistidium apocarpa*) Teton Co., Spence (1985). Telephone Canyon, Albany County (Porter 607); Long Canyon, Albany Co. (*Rollins, 63*), (Sheridan Co.), Porter (1935).. (As *G. dupretii* Thér.) Plumbago Canyon, Albany County (*Porter 482*); Hoback Canyon, Teton Co. (*Porter 1162*), Porter (1935).



Courtesy FNA Association, FNA 27, 2007

The following specimens seem to have been *Shistidium apocarpum.* They need reexamination by a Grimmiaceae expert. Albany Co.: Laramie Mtns., Roger Canyon, ca. 8 air mi NE of Laramie, limestone outcrops with *Cercocarpus montanus*, 2400 m, 7 Jun 1993, *Buck 23174,* old fruit, some with opercula, (NY). Park Co.: 6500 ft, moderately cribrose, *Hermann 20032,* small plants with yellowish red peristome teeth (RM). Fremont Co.: thin soil on undersurface of granite ledge on slope, W slope of Fiddler's Lake (Wyo. Rte. 131), 9300 ft, 22 mi SSW of Lander, 18 Jun 1973, *Hermann 25297* (RM). Lincoln Co.: 6700 ft, *Hermann 25597* (RM). Park Co.: granite bluff along Route 212, Shoshone Natl. Forest, 7500 ft, 46 mi NW of Cody, 19 Jul 1965, *Hermann 20063*

(RM). Yellowstone Natl Park: on US14, 16 & 20 just before E entrance to Park, border with Shoshone Natl Forest, 6951 ft, granitic rocks, spruce-pine woods, *Juniperus* woodland, xeric, S slope, 6 Jul 1985, *Eckel 94082303,* c.fr., with *Dicranoweisia crispula* (BUF).

Schistidium confertum (Funck) P. Bruch & W.P. Schimper, Bryol. Europ. 3: 99. 1845.
Grimmia conferta Funck, Deutschl. Moose 18. 1820.

Wyoming (FNA Vol. 27, 2007). (As Grimmia *apocarpa* var. *conferta* Fk.) Wyoming: Yellowstone Natl Park (*1470*). Upper Falls (*1454, 1458, 1461, 1468* and fo. *rivularis* Nees et H. (*1485*), Roell (1893).

Schistidium dupretii (Thér.) Weber, Phytologia 33: 106. 1976.
Grimmia dupretii Thériot, Bryologist 10: 63, plate 8. 1907.
Schistidium apocarpum var. *dupretii* (Thér.) Wijk & Marg.

Wyoming (FNA Vol. 27, 2007).

Schistidium frigidum H.H. Blom, Bryophyt. Biblioth. 49: 181, fig. 70. 1996.

Wyoming (FNA Vol. 27, 2007).

Schistidium occidentale (Lawton) Churchill, Advances Cladist. 1: 143. 1981.
Grimmia occidentalis Lawton, Bull. Torrey Bot. Club 94: 461, figs. 1–15. 1967.
Grimmia alpicola var. *rivularis* fo. *acutifolia* Grout

Wyoming (FNA Vol. 27, 2007). Montana, Wyoming; California, Nevada, Colorado.

Albany Co.: 9000 ft, *Hermann 17761* (RM). Sublette Co.: Bridger Wilderness, Wind River Range Lake Jacqueline, ca. 9800 ft , 42°57'30"N, 109°37'W, on rocks in stream, 14 May 1989, *Andrus 7779* (BING).

Schistidium rivulare (Brid.) Podpera, Beih. Bot. Centralbl. 28(2): 207. 1911.
Grimmia rivularis Brid., J. Bot. (Schrader) 1800(1): 276. 1801.
Grimmia alpicola of American authors
Grimmia alpicola var. *rivularis* (Brid.) Wahl.
Grimmia platyphylla Mitt.
Schistidium platyphyllum (Mitt.) Persson
Schistidium rivulare subsp. *latifolium* (Zetterst.) Bremer
Schistidium submuticum subsp. *arcticum* H.H. Blom

Wyoming (FNA Vol. 27, 2007). Yellowstone Natl Park: (as *Schistidium rivulare* (Brid.) Podp. ssp. *rivulare*) 1938 Bartley & Pontius (NY) in Bremer 1980. *Schistidium rivulare* (Brid.) Podp. Teton Co., Spence (1985). See Roell citation under *Schistidium confertum* fo. *rivularis.* Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: (var. *rivulare*) moist soil in shaded crevice of calcareous sandstone bluff, Roger Canyon, 8000 ft, 10 mi NE of Laramie, 19 Aug 1961, *Hermann 17156* (RM). Carbon Co.: (var. *rivulare*) W slope of Sierra Madre, Battle Creek Canyon, 8500 ft, streamside forest of Engelmann Spruce, on rocks in dry places, 18 Aug 1964, *Porter 9718* (RM). Fremont Co.: (as var. *rivulare*) wet rock in stream on partially shaded slope, along Fiddler's Lake Rd (Wyo. 131), 8600 ft, ca. 14 mi SSW of Lander, 18 Jun 1973, *Hermann 25304* (RM). Sublette Co.: (var. *rivulare*) Bridger Wilderness,

Wind River Range, Lake Sequa, 9940 ft, 42°57'30"N, 109°34'W, 17 May 1989, *Andrus 7882* (BING); Bridger-Teton Natl Forest, 4.6 mi N of Bondurant on US 191 & 189, wooded spruce bank, lush herbage, N slope, Hoback River valley, shaded sandstone rock, 5 Jul 1985, *Eckel 961258* (BUF). Teton Co.: (var. *rivulare*) vertical face of boulder on bank of Cascade Creek, near mouth of Cascade Canyon, W shore of Jenny Lake, 7000 ft, Teton Range, Grand Teton Natl. Pk., 19 Aug 1973, *Hermann 25583* (RM).

The specimen *Porter 9718* from Carbon Co. is the largest of its kind, with very elongate stems and leaves to 3.5 mm. The leaves are ovate-lanceolate to nearly triangular. Flowers (1973) described the group of *Grimmia* species as including 3.5 mm-long leaves. Others, Crum and Anderson (1981) and Lawton (1971), gave 2.5 and 2.8 mm lengths. Lawton (1971) indicated the stems of var. *rivulare* can be to 10 cm long.

Var. **rivulare**: (As *Grimmia alpicola* Sw. ex Hedw. Including following synonymy.
Grimmia apocarpa var. *alpicola* (Hedw.) Roehl
Grimmia helvetica Schkuhr
Schistidium alpicola (Hedw.) Limpr.

In all states and provinces of the Pacific Northwest; Alaska, Cal., Colo., Manitoba, S. Dakota, Michigan, Ontario; Newfoundland and Labrador to North Carolina. *Grimmia alpicola* Hedw. Big Sandstone Creek, Carbon Co. (*Porter 927*), Porter (1935).

Lincoln Co.: Salt River Range, Greys River Valley, 18 mi SE of Alpine Junction, on boulder in partial clearing in spruce-fir woods along Porcupine Creek, 6600 ft, 30 Aug 1973, *Hermann 25594* (RM). Park Co.: granite outcrop on bank of Crandall Creek, 6500 ft, Shoshone Natl. Forest, 36 mi NW of Cody, 19 Jul 1965, *Hermann 20038 1/2*, with *Orthotrichum* sp. (RM). Sheridan Co.: crevice in limestone boulder in spruce-fir forest, Big Horn Natl Forest, T57N, R89W, Sect. 34, 19 Jun 1992 *McKee 92-F5,* c.fr., dehisced young, not eroded (RM). Sublette Co.: (var. *alpicola*) on boulder on open slope, W shore of Lower Green River Lake, 7950 ft, Wind River Range, 50 mi N of Pinedale, 19 Jun 1973, *Hermann 25321* (RM).

Var. **latifolium** (Zett.) Crum & Anderson = *Schistidium rivulare* (Brid.) Podp. (FNA Vol. 27, 2007). The following synonymy was originally published for var. *latifolium*:
Grimmia alpicola var. *latifolia* (Zett.) Moell.
Grimmia apocarpa fo.latifolia Zett.
Grimmia platyphylla Mitt.
Schistidium alpicola var. *latifolia* (Zett.) Limpr.

B.C., Alberta, Idaho, Mont., Wyoming; Alaska, New Brunswick.

Park Co.: 6000 ft, on basaltic sand or rock, 1 Apr 1988, *Vukelich s.n.*, leaves 0.7–1 mm broad (BUF).

Schistidium tenerum (Zett.) Nyholm, Ill. Moss. Fl. Fennoscand., Musci, 775. 1969.
Grimmia tenera Zett., Kongl. Svenska Vetensk. Acad. Handl., n. s. 13(13): 17. 1876.
Grimmia tenuicaulis Williams

Wyoming (FNA Vol. 27, 2007). B.C., Wash., Alberta, Mont., Wyoming; Alaska, Yukon, NorthW Territory, Col; Greenland. (As *Grimmia tenuicaulis* Williams) Dale Creek, Albany Co. (*Porter 979*), Porter (1937).

Albany Co.: 8500 ft, *Hermann 17751 1/2* (RM).

SCIURO-HYPNUM (Hampe) Hampe, Linnaea 38: 220. 1874. (Brachytheciaceae)
Hypnum sect. *Sciuro-hypnum* Hampe, Flora 50: 76. 1867.

The sexual condition of *Sciuro-hypnum* is, as in *Brachytheciastrum*, autoicous (but dioicous in *S. hylotapetum* and *S. latifolium*); the genus *Brachythecium* has both dioicous and autoicous species.

Sciuro-hypnum glaciale (Schimper) Ignatov & Huttunen, Arctoa 11: 270. 2003.
Brachythecium glaciale Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 6: 15, plate 542. 1853.

Wyoming; "Soil, rock, near glaciers, open, cold habitats; low to high elevations (0–3200 m); Greenland; Wyo;" "*Sciuro-hypnum glaciale* has a wide distribution globally, but is probably locally common only in Scandinavia. In North America it is confirmed in Greenland and high mountains in Wyoming, but probably occurs also in other regions of the North American Arctic" (Ignatov, FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, alpine snow melt area, small lake in vast depression, ca. 100 m N of Beartooth Scenic Byway, boggy shore crossed by rills, *Carex* spp.—Bryidae wetlands, wet tussocks, on clay soil, 10,500 ft (3200 m), 20 Aug 2008, *Kosovich-Anderson 3508* (MHA, MO, RM).

The range of this species is bipolar arctic-alpine. "... the collection from Wyoming is the only one in continental North America. It extends the known range by no less than 4400 km representing an extraordinary arctic-alpine disjunction in the Rocky Mountains" (Kosovich-Anderson & Ignatov 2010).

Sciuro-hypnum latifolium (Kindb.) Ignatov & Huttunen, Arctoa 11: 270. 2003.
Brachythecium latifolium Kindb., Forh. Vidensk.-Selsk. Kristiania 1888(6): 8. 1888.
Brachythecium nelsonii Grout
Sciuro-hypnum nelsonii (Grout) Ochyra & Żarnowiec

Wyoming (FNA Vol. 28, 2014). (As *Brachythecium nelsonii*) Pole Mt., Albany County (*Porter 537*); Brooklyn Lake, Albany County (*Nelson 5172*); Lake and Canyon, Yellowstone Natl Park (*Smiy*). *Nelson's 5172* is the type referred to by Grout (1902), Porter (1935). Albany Co. (*Porter 537;1433*); Yellowstone Natl Park (*Smiy*), Porter (1934). Albany Co., Yellowstone Natl Park, Porter (1937). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Brachythecium nelsonii*) Albany Co.: wet bank of pond in mountain meadow, 1 1/4 mi S of Brooklyn Lake, 10,000 ft, Medicine Bow Mts, 9 mi W of Centennial, *Hermann 17690* (RM); Medicine Bow Mountains, Barber Lake Picnic area, 2.5 mi NW of Centennial, along Libby Creek, 8720–8740 ft, *Pinus contorta* forest, streamside, on rock, 7 Jun 1993, *Miller 10,259* (NYS). Big Horn Co.: Big Horn Mts., Jul 1896, *Nelson 2234* (RM). Park Co.: Shoshone Natl. Forest, Beartooth Plateau, Morrison Jeep Trail, Dollar Lake, SW shore of lake, fen, on soaked boggy soil, 9400 ft, 1 Aug 2010, *Kosovich-Anderson 7754* (RM). Sheridan Co.: on wet soil along streamlet in sloping patterned fen on south side of drainage with a raised spring mound, with *Salix planifolia* and *Pinus contorta,* ca. 0.3 mi up Bruce Creek, ca. 1.5 mi ENE of Granite Pass, Bighorn Natl. Forest, 8870 ft (2704 m), 7 Sep 2010, *Lenz 4323* (RM); also wet decayed log in seep zone near S edge of wet meadow, Upper Preacher Rock Bog, ca. 0.45 mi WNW of Preacher Rock, Bighorn Natl. Forest, 8285 ft (2526 m), 8 Sep 2010 m, *Lenz 4399* (RM). Sublette Co.: 10,324 ft, *Rolston 85103* (CSU); 10,595

ft, *Rolston 85096* (CSU). Yellowstone Natonal Park: slope along old road, Crescent Hill, 3 Sep 1948, *Conard 2045* (NY).

This species grows on wet decaying logs and soil in forested areas in basin and patterned fens, hanging or quaking bogs over water, and wet (mountain) meadows, wet banks, ditches and shallow waters of (beaver) ponds, with seeps, springs and creeks, streamsides in areas of lakes and ponds, with herbaceous vegetation of *Carex* and *Juncus* spp., *Alchemilla, Salix* spp., in thickets, *Salix planifolia, Picea engelmannii, Pinus contorta.* Moss associations include *Aulacomnium palustre, Plagiomnium ellipticum, Brachythecium erythrorrhizon.* Soils are often clay or marl as well as sand.

(As *Brachythecium nelsonii*) Grout (1902 1928) placed this species right beside *B. rivulare*, which it resembles except for its flat leaves (stems appear complanate, flattened, not dendroid), nearly entire leaf margins and extensive area of inflated hyaline cells extending to near the costa. Flowers (1973) wrote that *B. starkei* did not have the linear upper leaf cells of *B. nelsonii*; the *Hermann 17690* specimen from Albany Co. shows this (the leaves in this specimen have almost no acumination). Flowers (1973) described *B. nelsonii* as "sometimes thin and straggling, mostly bright green, often becoming yellowish or straw colored." The specimen was first identified as *B. rutabulum*, which has this vivid green, but the plant is apparently dioicous (only males seen) and the alar cells are abruptly inflated and decurrent. (See also Porter 1934, as *B. rutabulum*)

Sciuro-hypnum oedipodium (Mitt.) Ignatov & Huttunen, Arctoa 11: 270. 2003.
Hypnum oedipodium Mitt., J. Linn. Soc., Bot. 8: 32, plate 5 (lower right). 1864.
Brachythecium collinum var. *holzingeri* Grout
Brachythecium curtum (Lindb.) Limpr.
Brachythecium holzingeri (Grout) Grout
Brachythecium oedipodium (Mitt.) A. Jaeger
Brachythecium starkei subsp. *oedipodium* (Mitt.) Ren. & Card.
Brachythecium starkei var. *curtum* (Lindb.) Warnst.
Brachythecium starkei var. *explanatum* (Brid.) Mönk.

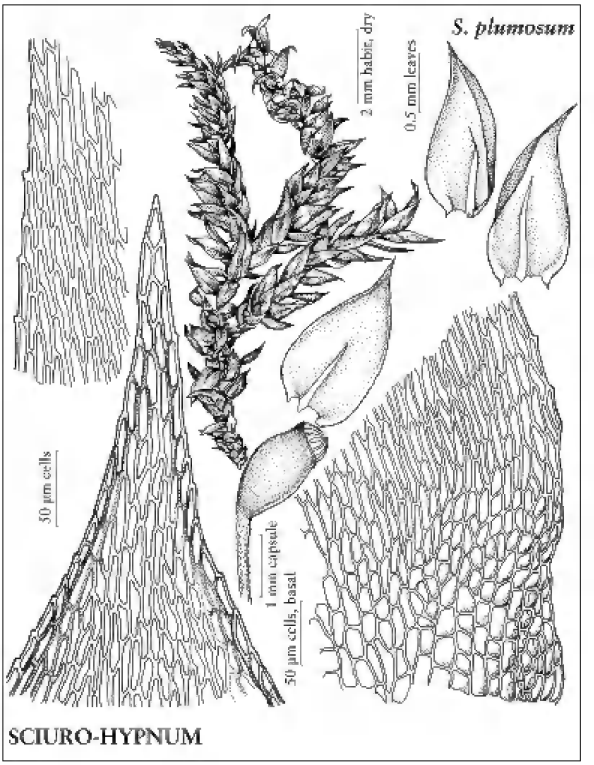
Wyoming (FNA Vol. 28, 2014). (As *Brachythecium starke)*, Wyoming: Yellowstone Natl Park, subspecies *Oedipodium* Mitt. fo. *depauperata* (sic) (*1593*) (Roell 1893). (As *Brachythecium oedipodium*) Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Brachythecium oedipodium*) Albany Co.: carpeting floor of spruce forest, Little Brooklyn Lake, 10,400 ft, Medicine Bow Mts, 7 mi NW of Centennial, 27 Aug 1975, *Hermann 26721* (RM). Fremont Co.: thin soil on boulder on spruce-fir slope, Burroughs Creek Rd., 8400 ft, Absaroka Range, 14 mi N of Dubois, *Hermann 25524* (det. Lawton) (RM). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, under late snow patch on steep slope N of switchback, rills and snowbeds, 3200 m, *Weber, B–44307* (with *B. salebrosum*). (COLO, RM, US). Lincoln Co.: clay bank of Greys River in meadow, 6600 ft, Salt River Range 18 mi SE of Alpine Junction, 30 Aug 1973, *Hermann 25596* (RM). Sublette Co.: Bridger Wilderness, Wind River Range 2, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at S end of lake, 14 May 1989, *Andrus 7792b* (BING). Teton Co.: on US 26 & US 287, 1.3 mi W of Togwotee Pass, Bridger-Teton Natl. Forest, ca. 9000 ft, *Picea-Pinus flexilis, Pinus contorta* v. *latifolia*, xeric, some *Artemisia*, forest floor, 6 Jul 1985, *Eckel 9408160,* c.fr. (BUF, RM).

(As *Brachythecium oedipodium*) "The following features distinguish *B. starkei* from *B. curtum*: plants smaller, having longer-pointed leaves with a longer costa (in branch leaves at least) and narrower cells. *Brachythecium starkei* differs from *B.reflexum* in having narrower leaf

decurrencies and narrower cells" Crum & Anderson (1981: 1032). Lawton (1971) indicated that in *B. reflexum*, the costa extends to the apex or nearly so: this may help to distinguish *B. starkei*. A specimen from Poland (Ochyra Musci Poloniae Exsiccati 280) seems to suit general descriptions of *B. starkei* var. *explanatum*. However, its medial leaf cells were as elongate as any seen in *B. nelsonii* or *B. rivulare*. They were sharply serrulate and the leaves were more narrowly oblong-lanceolate, rather than the deltoid things of *B. nelsonii* and *B. rivulare*.

Brachythecium starkei is currently *Sciuro-hypnum starkei* (Brid.) Ignatov & Huttunen, not reported from Wyoming, a species of northeastern North America with a western outlier in Wisconsin (Ignatov, FNA Vol. 28, 2014).



Courtesy FNA Association, FNA 28, 2014

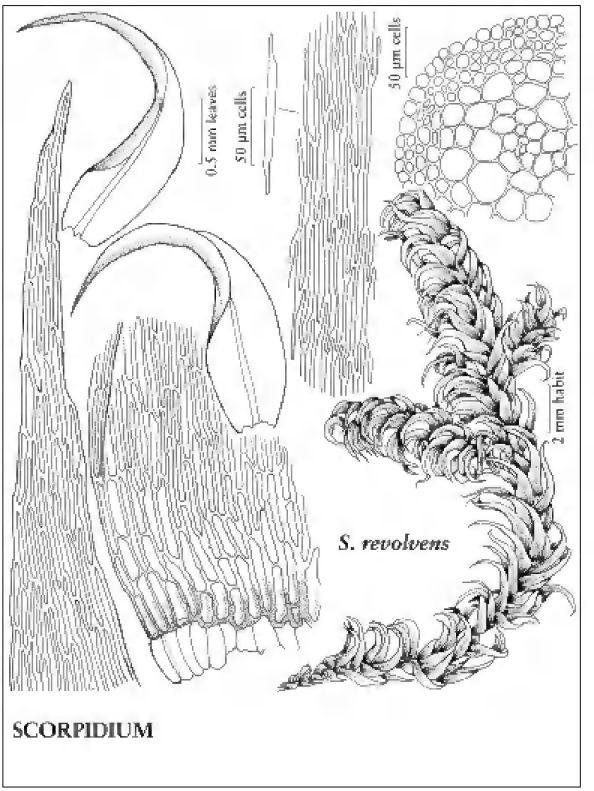
Sciuro-hypnum plumosum (Hedw.) Ignatov & Huttunen, Arctoa 11: 270. 2003.
Hypnum plumosum Hedw., Sp. Musc. Frond., 257. 1801.
Brachythecium plumosum (Hedw.) Schimp.
Eurhynchium semiasperum Müll. Hal. & Kindb.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

SCORPIDIUM (Schimper) Limpr., Laubm. Deutschl. 3: 570. 1899. (Calliergonaceae)
Hypnum subg. *Scorpidium* Schimper, Syn. Musc. Eur., 650. 1860.
Limprichtia Loeske

[*Scorpidium cossonii* (Schimp.) Hedenäs, excluded.]

Shoshone Natl Forest, NW Wyoming (Kosovich-Anderson 2010), incorrect citation.



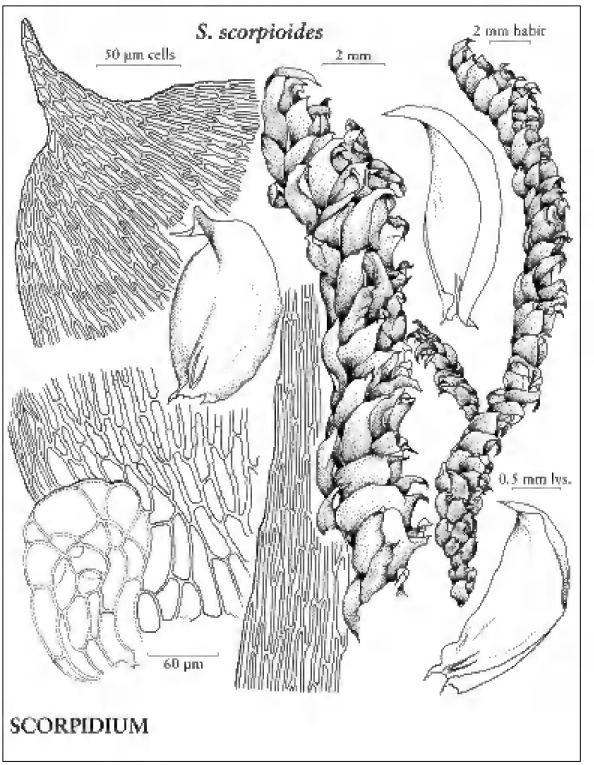
Courtesy FNA Association, FNA 28, 2014

Scorpidium revolvens (Sw.) Rubers in A. Touw and W.V. Rubers, Nederl. Bladmoss., 380. 1989.
Hypnum revolvens Sw. ex Anonymo, Monthly Rev. 34: 538. 1801.
Drepanocladus revolvens (Sw.) Warnst.
Drepanocladus revolvens var. *miquelonensis* (Ren. & Card.) Grout
Limprichtia revolvens (Sw.) Loeske

Wyoming (FNA Vol. 28, 2014). (As *Drepanocladus revolvens* (Sw.) Warnst.): Wynne 1944; who gives a dot map showing a station in the Big Horn Mountains area of Wyoming. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Limprichtia revolvens*) Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1/2 mi SW of Barnes Lake, 9760 ft, 42°57'N, 109°36'W, terrace fen, 15 May 1989, *Andrus 77816c* (BING).

(As *Limprichtia revolvens*) This is a beautiful lustrous golden-coppery to red moss with inflated cortical cells, small central strand and thick-walled alar cells often not coming off with the dissected leaf. They are described variously as few and hyaline with pitted basal cells. Crum and Anderson (1981) make the useful observation that the cells across the insertion are somewhat darker "oblong-linear, with thickened, porose walls" grading to the variety *intermedius* where the cells across the insertion are "not much differentiated." The few cells at the basal angles are "hyaline and slightly enlarged." It appears that the costa is somewhat short for the genus, too. The presence of a central strand separates this from *D. vernicosus*.



Courtesy FNA Association, FNA 28, 2014

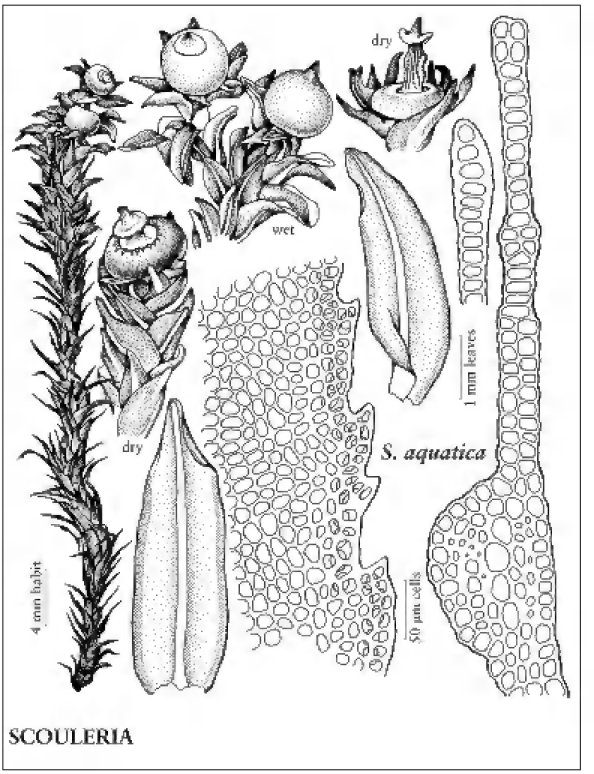
Scorpidium scorpioides (Hedw.) Limpr., Laubm. Deutschl. 3: 571. 1899 (Calliergonaceae)
Hypnum scorpioides Hedw., Sp. Musc. Frond., 295. 1801.

Wyoming (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: wet marl in calcareous fen complex at the base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, Shoshone Natl. Forest, 6600 ft, 12 Aug 1990, *Elliott 1749* (BUF).

SCOULERIA Hook., Bot. Misc. 1: 33. 1829. (Scouleriaceae)
Grimmia sect. Scouleria (Hook.) Müll. Hal.
Grimmia subgen. *Scouleria* (Hook.) Lesq. & James

Scouleria aquatica Hook. in T. Drumm., Musc. Amer., 63. 1828.
Guembelia scouleri Müll. Hall.
Scouleria aquatica var. *catilliformi* Müll. Hall.
Scouleria aquatica var. *nigrescens* Kindb. in Macoun
Scouleria aquatica var. *virescens* Kindb. in Macoun
Scouleria muelleri Kindb. in Macoun
Scouleria nevii Müll. Hall. in Macoun



Courtesy FNA Association, FNA 27, 2007

Wyoming (FNA Vol. 27, 2007). In all states and prov. in the Pacific Northwest: Alaska, Calif. Laramie Peak, Albany Co. (*Nelson 7559*); Little Goose Creek, Sheridan Co. (*Nelson 2416*, in

part); Teton Co., Amphithestre Lake, (*Williams 1035b*); Teton Co., Leigh Lake (*Porter 1189*), Porter (1935). Teton Co., Spence (1985). Type of var. *catilliformi* Müll. Hall. in Roll, Bot. Centralbl. 44: 389 1890. Yellowstone River, Wyoming (Churchill 1985). "*Scouleria catilliformi* C. Müll. on stones in water in Yellowstone Natl. Park, Wyom." (Roell 1893); also as the new variety *Scouleria aquatica* var. *catilliformi* (1456) of which Yellowstone Park would be the type locality. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 7800 ft, *Herman 25926* (RM); Laramie Peak, *Nelson 7559* (MO, NY, RM, US). Park Co.: Crandall Creek, 6500 ft, *Hermann 20041* (RM); (associated with *Hygrohypnum styriacum* specimen, q.v.: Shoshone Natnl. Forest, Beartooth Plateau, Beartooth Creek, granite debris along the creek, attached to boulders periodically wet by spray and seasonally covered with fast flowing water, assoc. with *Scouleria aquatica*, 109° 36.010–020'W, ca. 8900 ft (2700 m), 23 Aug 2009, *Kosovich-Anderson 5431* (COLO). Sheridan Co.: Big Goose Creek, *Rollins 360* (RM); Little Goose Creek, 18 Jul 1896, *Nelson s.n.* (RM). Teton Co.: Teton Range, 7000 ft, *Hermann 25582* (RM).

SELIGERIA P. Bruch & W.P. Schimper, Bryol. Europ. 2: 7. 1856. (Seligeriaceae)

Seligeria campylopoda Kindb. in J. Macoun and N.C. Kindb., Cat. Canad. Pl., Musci, 41. 1892.
Seligeria recurvata (Hedw.) P. Bruch & W.P. Schimper var. *arcuata* Lesq. & James
Seligeria subcampylopoda Kindb.

Sweetwater Co.: Teton Natl Forest, 5.3 mi N of Bondurant on US 191 and 189, Hoback River Valley, N-facing slope, rich moist valley woodland, 5 Jul 1985, *Eckel 1121885* (ALTA, BUF, RM).

Although *Seligeria campylopoda* is not reported for Wyoming (FNA Vol. 27, 2007), this was probably an oversight as the author of *Seligeria* (D.H. Vitt) in FNA also verified the species noted (Eckel 1986).

SPHAGNUM L., Sp. Pl. 2: 1106. 1753; Gen. Pl. ed. 5, 487. 1754. (Sphagnaceae)

Wyoming seems to be rather depauperate of plants of this genus (14 species), and Colorado with even less (11 species). This depauperation in Colorado is attributed to the "elevated landscape (which) provides mineral-rich aquatic habitats (cf. soligenous water from run-off, mineral-rich); we have no areas in which the wetlands are dependent upon rain-water alone (ombrotrophic, 'poor in nutrients'). Our fens are not very acid (acid = oligotrophic, 'poor in minerals'), hence many of the northern *Sphagnum* species are excluded from this area" (Weber & Wittmann 2007). The moss flora of the Aleutian Islands, in contrast, has 23 species (Schofield & Talbot, in prep.).

[Sphagnum acutifolium Ehrh., excluded.]

Shoshone Lakes in Yellowstone Natl Park (Coulter, in 1872) (Nelson 1900), "no material seen," Porter (1935). Note: "The names *Sphagnum acutifolium* Schrader and *S. nemoreum* Scopoli (doubtful name) have also been used (for *S. capillifolium*, q.v.) (FNA Vol. 27, 2007). Otherwise, *S. acutifolium* is a name not used for the flora of North America.)

Sphagnum angustifolium (Warnst.) C.E.O. Jensen, Bih. Svenska Vetensk.-Akad. Handl. 16(9): 46. 1891.
Sphagnum recurvum var. *angustifolium* Warnst., Nyt. Mag. Naturvidensk. 31: 213. 1888.
Sphagnum amblyphyllum var. *parvifolium* (Sendtner) Warnst.
Sphagnum flexuosum var. *tenue* (H. Klinggraff) Pilous

Sphagnum parvifolium (Warnst.) Warnst.
Sphagnum recurvum var. *parvifolium* Warnst.
Sphagnum recurvum var. *tenue* H. Klinggraff

Wyoming (FNA Vol. 27, 2007), including a boreal distribution extending down into states just north of those bordering the southern United States and absent from the central plains states. Park Co. Top Lake Fen, boggy southwestern shore of lake, on wet peaty soil, abundant in low hummock, assoc. *Polytrichum commune*, *Kosovich-Anderson 5773* (pers. herb.) (Kosovich-Anderson 2010). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, 19 Aug 1973, *Weber B–44268,* annot. Andrus (COLO, RM).

Sphagnum annulatum Warnst., Bot. Centralbl. 76: 422. 1898.
Sphagnum jensenii var. *annulatum* (Warnst.) Warnst.

Wyoming (FNA Vol. 27, 2007); with generally a boreal distribution just entering the northern United States.

Sphagnum annulatum var. porosum (Warnst.) W. S. G. Maas = Sphagnum jensenii H. Lindb.

[*Sphagnum capillifolium* (Ehrhart) Hedw., Fund. Hist. Nat. Musc. Frond. 2: 86. 1782, excluded.]
Sphagnum palustre var. *capillifolium* Ehrhart, Hannover Mag. 18: 235. 1780.
Sphagnum capillaceum (Weiss) Schrank
Sphagnum capillifolium var. *viride* Jennings
Sphagnum margaritae H.A. Crum

Cited for Wyoming by FNA (FNA Vol. 27, 2007); with a boreal to northern American states distribution. (As *Sphagnum capillaceum*) Yellowstone Natl Park, Porter (1937).

I have no records for this species. I've determined several Porter specimens (*1198 & 1199*) from 1932 as *S. russowii* so I expect that is what the record of *S. capillifolium* is; Weber and Wittman (2007) also exclude *S. capillifolium* from the Colorado flora.

Sphagnum contortum Schultz, Prodr. Fl. Starg. Suppl., 64. 1819.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007), with a mid-boreal, northern American states distribution in the east and west, with plains states and provinces absent.

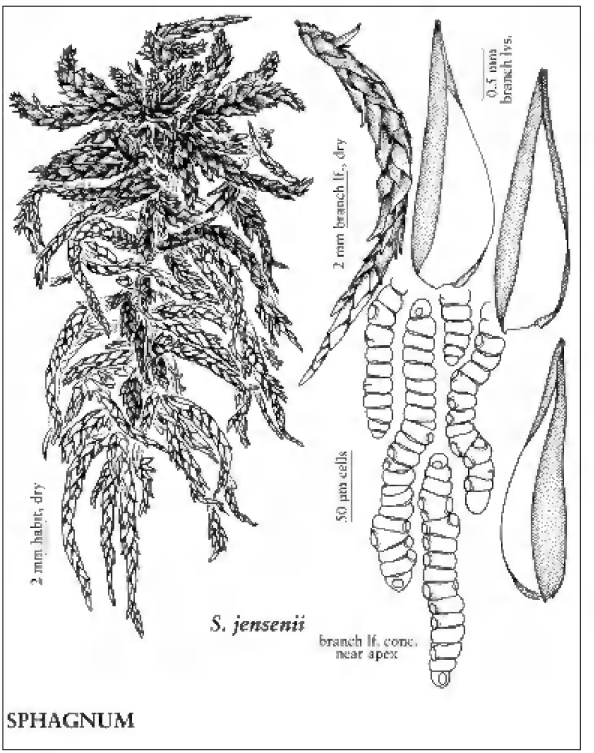
A specimen from Wind River is in BING.

Sphagnum dusenii Russow & Warnst. = Sphagnum majus (Russow) C.E.O. Jensen subsp. majus.

Sphagnum fimbriatum Wils. & Hook. in J. D. Hook., Fl. Antarct., 398. 1847.
Sphagnum bolanderi Warnst.

Not recorded for Wyoming by FNA; the subsp. *concinnum* (Berggren) Flatberg & Frisvoll grows in Alaska (McQueen & Andrus, FNA Vol. 27, 2007); s.l., the species is boreal and north to middle American states, with a corridor of absence in the central plains states. "*Sphagnum fimbriatum* Wils. var. *densum* and var. *gracilescens* in Yellowstone Nat.-Park, Wyom." (Roell 1893).

Note that it is Roell himself who identified his own collections (the Torfmoosen). "In Great beds on wet bottoms: Obsidian Creek, Yellowstone Natl Park Jul 24 1899, 6118; Sylvan Geysers, Jul 26, 6181" (*Nelson 1900*), Porter (1935). Beaver Lake and Sylvan Geysers in Yellowstone Natl Park (*Nelson 6118 & 6181*), Porter (1935). Yellowstone Natl Park, Porter (1937). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 27, 2007

Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, 19 Aug 1973, *Weber B–44287* (annot. Andrus) (COLO, RM). Yellowstone Natl Park: in great beds on the shores of the lake, Beaver Lake, 24 Jul 1899, *Nelson & Nelson 6118* (printed label, annot. Andrus) (RM); in the bogs or the open woods, Sylvan Geysers, 26 Jul 1899, *Nelson & Nelson 6181* (annot. Andrus) (RM); geothermal fen complex, with *Sphagnum capillifolium* and *S. platyphyllum*, along Bog Creek at 2500 m (8200 ft), the species occurred "on the tips of strings above pools with pH as low as 2.9 *Lemly & Cooper 848*, COLO, YELL, BING)" see also Lemly, Andrus & Cooper (2007).

Note that Lemly, Andrus, and Cooper (2007) described this species as a first record for Wyoming.

Sphagnum fuscum (Schimper) H. Klinggraff, Schriften Phys.-Ökon. Ges. Konigsberg 13: 4. 1872.
Sphagnum acutifolium var. *fuscum* Schimper, Mém. Hist. Nat. Sphaignes, 64. 1857.
Sphagnum tenuifolium Warnst.
Sphagnum vancouveriense Warnst.

Wyoming (FNA Vol. 27, 2007); the species is boreal and north to middle American states, with a corridor of absence in the southern and central plains states. Fox Park, Albany County (*Nelson 9054*), Porter (1935). Albany Co., Porter (1937).

Albany Co. or Carbon Co.?): Medicine Bow Mts., bogs, in Fox Park, *Nelson 9054* (RM), "Plants of Wyoming from the Rocky Mtn Herbarium" (printed label, annot. R. Andrus)

Sphagnum jensenii H. Lindb., Acta Soc. Fauna Fl. Fenn. 18(3): 13. 1899.
Sphagnum annulatum var. *porosum (*Warnst.) W.S.G. Maas

Not reported for Wyoming by FNA (FNA Vol. 27, 2007); there are no records reported for American States (other than Alaska) south of the border with Canada.

Albany Co.: (as *Sphagnum annulatum* var. *porosum)* Medicine bow Mts., bog below lookout W of Snowy Range, 18 Jul 1930, *Solheim 388* (annot. Andrus) (RM). Carbon Co.: (as *Sphagnum annulatum* var. *porosum*): Medicine Bow Range between Silver Lake and Headquarters Park on Highway 130, 10,000 ft, small pond in meadow below the road, forming beds at edge of pond, *Porter 9727* (annot. Andrus) (RM).

The following additional specimens were noted by Andrus and Kosovich-Anderson (2011):

Albany Co.: Medicine Bow Natl Forest, ca. 1 mi from trailhead of North Gap Lake Trail, growing around several small ponds located adjacent to the trail, Aug 2001, *Booth and Jackson s.n.* (BING); Medicine Bow Mountains, near Headquarters of the Park, 10,500 ft (3170 m), 29 Jul 1934, *Porter 1693* (CU). Carbon Co.: near Silver Lake, 10,400 ft (3170 m), 15 Aug 1962, *Shushan s.n.* (CANM); W slope of Snowy Range, 10,000 ft (3050 m), 18 Aug 1930, *Solheim 388* (CU); Medicine Bow Range, NW of Silver Lake, 10 Jul 1960, no collector, *s.n.*. (DUKE); Medicine Bow Mountains, North Fork of Rock Creek Fen Complex, 9600 ft (2925 m), 22 Sep 2007, *Kosovich-Anderson 1725, 1754* (both BING, COLO, MO, RM). Medicine Bow Mountains, floating in an alpine stream, 11 Aug 1953, *Welch 15926* (CU, NY).

Sphagnum lindbergii Schimper, Öfvers. Kongl. Vetensk. Akad. Förh. 14: 126. 1857.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007); the species is boreal-Canadian with outliers in New York State and New Hampshire in the east, Alaska, Washington and Colorado in the west. The report of this species for Colorado "in the Flora of North America (2007). The specimen of record is actually from Yellowstone Natl Park, Wyoming" Weber & Wittmann (2007).

Yellowstone Natl Park: from a geothermal fen, 8200 ft (2500 m) near headwaters of Sulphur Creek, forming mats near bubbling pools, *Lemly & Cooper 887, 888, 890* (COLO, YELLO, BING).

For the geothermal fen, "Water within the site had a pH of 3.3 to 5.1 and temperature of 17 to 23° C, with the most acid water being the warmest," growing with liverworts and *Drepanocladus* sp." (Lemly, Andrus & Cooper 2007). "At the eastern, downslope end of the site, it formed a continuous lawn beneath *Carex aquatilis* and *Eriophorum angustifolium*. At the western, upslope end of the site, it cocurred at the base of low hummocks in association with *S(phagnum) riparium* Ångstr.... The

hummocks also supported a few *Pinus contorta* and several species of ericaceous shrubs, including *Kalmia polifolia* and *Vaccinium scoparium*." Rare and endangered in the conterminous United States (Andrus et al. 1992).

[*Sphagnum majus* (Russow) C.E.O. Jensen in Bot. Forening Kobenhavn, Festskrift, 106. 1890 subsp. *majus*, excluded.]
Sphagnum cuspidatum var. *majus* Russow, Arch. Naturk. Liv- Ehst- Kurlands, Ser. 2, Biol. Naturk. 7: 136. 1865.
Sphagnum contortum var. *platyphyllum* (Lindb.) Åberg.
Sphagnum dusenii Russow & Warnst.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007); a report for Wyoming would be a first for the western and plains states. It seems to be associated with eastern and western boreal Canada and the Great Lakes provinces and states.

(As *Sphagnum dusenii*) Medicine Bow Mts., Carbon County, *Solheim 388,* det. by Andrews (Porter 1935). (As *Sphagnum dusenii*) Carbon Co., Porter (1937).

Excluded (Porter 1935; Crum 1984.) No records from Wyoming. I've looked at everything I could find and it was all *S. annulatum*. *Sphagnum majus* has actually never been collected in the western U.S. as far as I can tell. The nearest sites would be in B.C., central Alberta and Minnesota.

[Sphagnum palustre L., excluded.]

I have yet to see any section *Sphagnum* from Wyoming. Those species have only been found along the W Coast by Andrus (in litt.).

Sphagnum platyphyllum (Lindb.) Warnst., Flora 67: 481. 1884.
Sphagnum laricinum var. *platyphyllum* Lindb., Not. Sällsk.Faun. Fl. Fenn. Förh. 13: 403. 1874.
Sphagnum contortum var. *platyphyllum* (Lindb.) Åberg.
Sphagnum grasslii Crum
Sphagnum laricinum var. *platyphyllum* Lindb. ex Braithw.
Sphagnum subsecundum var. *platyphyllum* (Braithw.) Card.

Wyoming (FNA Vol. 27, 2007). The species is boreal, western and clustered around the Great Lakes with a southern states and north-south corridore in the central plains states where it is absent. Ireland 1982. Sublette Co., Cooper & Andrus (1994). Wyoming, Crum (1984). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, 19 Aug 1973, *Weber B–44271* (annot. Andrus) (COLO, RM). Sublette Co.: (as *S. subsecundum* var. *platyphyllum*), Bridger Wilderness, Wind River Range, Lake Jacqueline, ca. 9800 ft, 42°57'30"N, 109°37'W, at lake edge, 14 May 1989, *Andrus 7778* (BING).

[*Sphagnum recurvum* P.-Beauv., excluded.]

All the material from the interior is referrable to *S. angustifolium*. *Sphagnum recurvum* s.str. is a coastal plain species from the East.

Sphagnum riparium Ångström, Öfvers. Kongl. Vetensk.-Akad. Förh. 21: 198. 1864.

Not reported for Wyoming by FNA (FNA Vol.27, 2007); again a boreal-Canadian distribution with some states along the Canadian border and Great Lakes states in the east. Yellowstone Natl Park, from a geothermal fen, 8200 ft (2500 m) near headwaters of Sulphur Creek, "water within the site had a pH of 3.3 to 5.1 and temperature of 17 to 23° C, with the most acid water being the warmest," growing with liverworts and *Drepanocladus* sp." (Lemly et al. 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Yellowstone Natl Park: "At the western, upslope end of the site, it occurred at the base of low hummocks, the hummocks also supported a few *Pinus contorta* and several species of ericaceous shrubs, including *Kalmia polifolia* and *Vaccinium scoparium," Lemly & Cooper 892* (COLO, WELL, BING) (Lemly et al. 2007).

[*Sphagnum robustum* (Russ.) Roell, excluded.]

This species is not reported for the North American flora area (FNA Vol. 27, 2007). Leigh Lake, Teton County (*Porter 1198 & 1199*), Porter (1935). Teton Co., Porter (1937).

Sphagnum russowii Warnst., Hedwigia 25: 225. 1886.
Sphagnum acutifolium var. *robustum* Russow.

Wyoming (FNA Vol. 27, 2007); a boreal Canadian and temperate American State distribution with a southern states and a north-south central plains corridor where it is absent, Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(Albany Co.: but probably Carbon:) Pond above headquarters Park, Medicine Bow Mts., 17 Jul 1933, *Solheim s.n.* (annot. Andrus) (RM).

Sphagnum squarrosum Crome, Samml. Deut. Laubm., 24. 1803.
Sphagnum squarrosum var. *imbricatum* Schimp.

Wyoming (FNA Vol. 27, 2007); boreal-Canadian, temperate American States, avoiding the southern States and central plains except South Dakota. A robust Sphagnum "tyically in loose carpets in coniferous forests" (McQueen & Andrus, FNA Vol. 27, 2007). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Teton Co.: Grand Teton Natl Park, Swan Lake, near Coulter Bay, 6500 ft, on a floating island in the lake, with sedges and *Menyanthes*, *Porter 7323* (annot. Andrus) (RM).

Sphagnum subsecundum Nees in J. Sturm et al., Deutschl. Fl. 2(17): species 3. 1819.
Sphagnum crispum R.E. Andrus

Wyoming (FNA Vol. 27, 2007); boreal-Canadian and temperate America with a corridor in the southern and central plains states where it is absent. Park Co.: Wind River Range, (BING). Crum 1984. Sublette Co., Cooper & Andrus (1994). "Seasonally flooded sites, not hummocks or higher terrain," Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sphagnum subsecundum var. platyphyllum = Sphagnum platyphyllum, q.v.

Sphagnum teres Ångström in C.J. Hartman, Handb. Skand Fl. ed. 8, 417. 1861.
Sphagnum squarrosum var. *teres* Schimp., Vers. Entw.-Gesch. Torfm., 64. 1858.
Sphagnum teres var. *squarrosulum* (Schimp.) Warnst.

Wyoming (FNA Vol. 27, 2007); boreal Canadian, temperate American states generally with a southern states and plains state's corridor where it is absent. Carbon Co., Porter (1937). Several locations (BING). Sublette Co., Cooper & Andrus (1994). "Seasonally flooded sites, not hummocks or higher terrain," Cooper & Andrus (1994). Wyoming (FNA Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Sphagnum warnstorfii Russow, Sitzungs.-Ber. Naturf.-Ges. Univ. Dorpat 8: 315. 1888.
Sphagnum warnstorfianum Du Rietz

Wyoming (FNA Vol. 27, 2007), with a boreal, northern American states distribution. Washakie Co., Porter (1937). Johnson Co., associated with *Warnstorfia tundrae,* Lenz (2006). Park Co. with *Aulacomnium palustre, Campylopus schimperi* (*Kosovich 2011a*). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

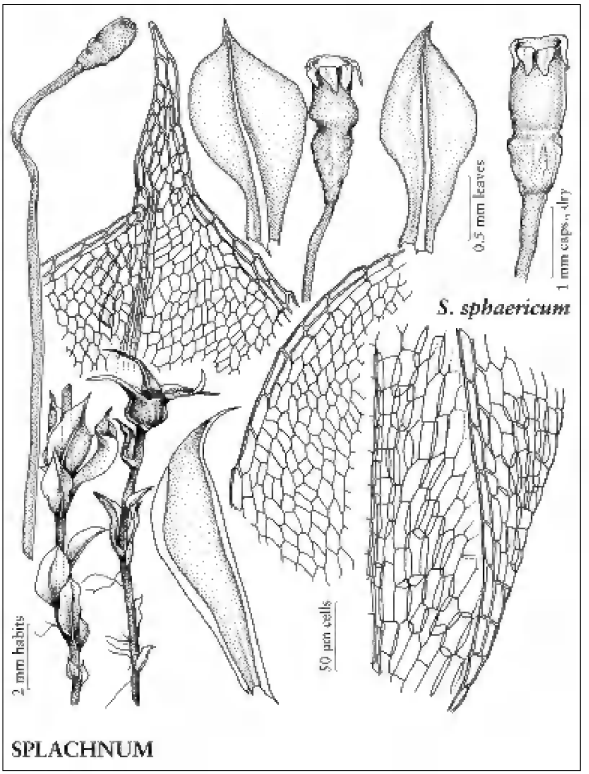
Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 2900 m, 19 Aug 1973, *Weber B–44272* (annot. Andrus) (COLO, RM).

SPLACHNUM Hedw., Sp. Musc. Frond., 51. 1801. (Splachnaceae)

Splachnum sphaericum Hedw., Sp. Musc. Frond., 55. 1801.
Splachnum ovatum Hedw.
Splachnum ovatum var. *sphaericum* (Hedw.) Dixon
Splachnum pedunculatum Lindb.

Wyoming (FNA Vol. 28, 2014). B.C., Wash., Alberta, Wyoming, Alaska; Labrador, New Brunswick. Cited for WY in Steere, l978, The Mosses of Arctic Alaska. Strauss And Cramer, Hirschsberg, Germany. For North American citations of distribution v. Cameron, R. G. l984, *Splachnum sphaericum* from Isle Royale, Michigan. Bryologist 87: 349–350. Occurrence: Isle Royal, MI; Gillam, Manitoba (Crum & Schofield), Washington (Lawton), Wyoming (Steere); Gaspe, Quebec (Crum & Anderson). Widespread circumboreal.

Yellowstone Natl Park: four mi from Old Faithful east, on road to Thumb, Aug 29 1951, *Lawton 1515* (YELLO),.



Courtesy FNA Association, FNA 28, 2014

STEGONIA Vent., Rev. Bryol. 10: 96. 1883. (Pottiaceae)
Pottia sect. Stegonia (Vent.) Müll. Hal.

Stegonia latifolia (Schwägr.) Vent. ex Broth., Laubm. Fennosk., 145. 1923.
Weissia latifolia Schwägr. in J. A. Schultes, Reise Glockner 2: 362. 1804.

Var. **latifolia.**
Anacalypta latifolia (Schwaegr.) Fuernr.
Pottia latifolia (Schwägr.) Müll. Hal. var. *latifolia.*
Stegonia latifolia (Schwaegr.) Vent. ex Broth.

Wyoming (FNA Vol. 27, 2007). Canadian Rocky Mountains, Wyoming; Alaska, Colorado. (As *Pottia latifolia* var. *latifolia*) cited by Lawton (1971).

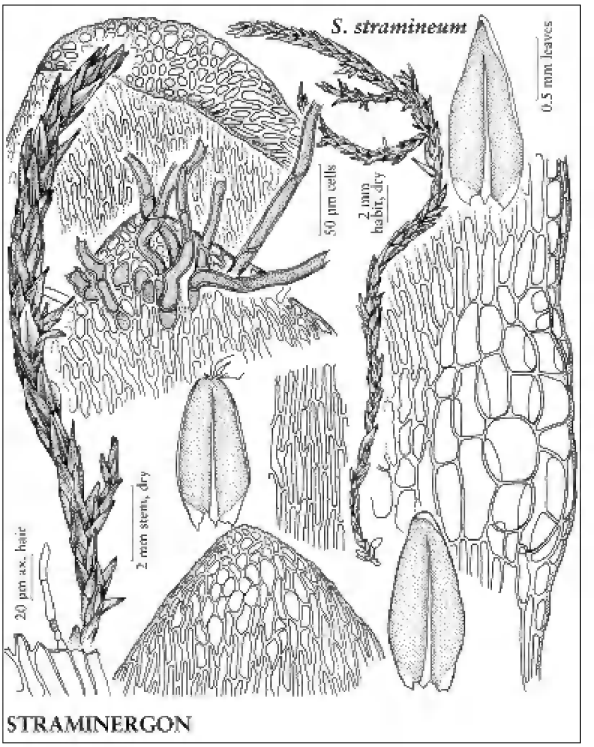
Stokesiella oregana (Sull.) Robinson = Kindbergia oregana (Sull.) Ochyra

STRAMINERGON Hedenäs, J. Bryol. 17: 462. 1993. (Calliergonaceae)

Straminergon stramineum (Dickson ex Brid.) Hedenäs, J. Bryol. 17: 463. 1993.
Hypnum stramineum Dickson ex Brid., Muscol. Recent. 2(2): 172. 1801.
Calliergon stramineum (Dickson ex Brid.) Kindb.

Wyoming (FNA Vol. 28, 2014). (As *Calliergon stramineum*) Teton Co., Spence (1985). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(As *Calliergon stramineum*:) Albany Co.: 10,800 ft, *Rolston 86091* (RM). Park Co.: 9700 ft, *Hartman 18545*, (RM); 2900 m, *Weber B–44280* (RM, COLO). Sublette Co.: Bridger Wilderness, Wind River Range, ca. 1/4 mi SW of Barnes Lake, 9780 ft, 42°59'N, 109°36'W, pothole fen, 15 May 1989, *Andrus 8813* (BING).

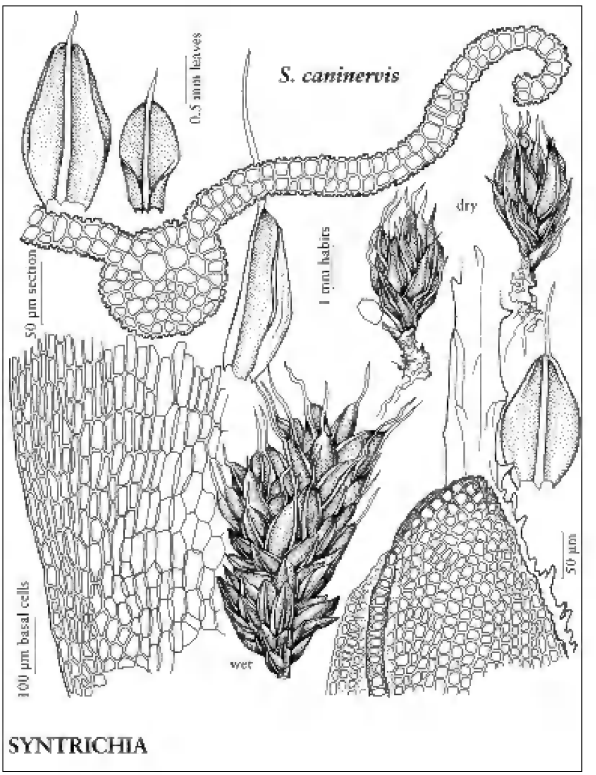


Courtesy FNA Association, FNA 28, 2014

SYNTRICHIA Brid., J. Bot. (Schrader) 1801(1): 299. 1801. (Pottiaceae)

Syntrichia caninervis Mitt., J. Proc. Linn. Soc., Bot., suppl. 1: 39. 1859.
Tortula bistratosa Flowers
Tortula caninervis (Mitt.) Broth.

Wyoming (FNA Vol. 27, 2007). (As *Tortula caninervis*) Washington, Oregon, Alberta, Idaho, Montana, Wyoming; California, Arizona, Nevada, Utah, Colorado. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 27, 2007

(All as *Tortula caninervis*) Albany Co.: soil at base of a rabbit brush, 7415 ft, 19 Mar 1988, *Vukelich s.n.* (BUF); Laramie Plains, 2 mi NE of Laramie, chugwater redbeds with *Astragalus, Eriogonum, Penstemon* and grasses, *Buck 23185* (NY), also a muticous form, same collection (*Buck 23188A*, NY), also *Artemesia* scrub (*Buck 23212*, NY); open prairie of Laramie Plains, ca. 2 mi due NE of Laramie city center, chugwater redbeds, low grasses and forbs, 7300 ft, rim of breaks, 7 Jun 1993, *Reese 18165* (RM, LAF, BUF); Laramie Plains, 2 mi NE of Laramie center, chugwater redbeds, rim of breaks, 7250–7300 ft, bare prairie soil between herbs, including *Astragalus, Eriogonum, Penstemon*, 7 Jun 1993, *Miller 10252* (NYS). Hot Springs Co.: on WY 120, 1 mi SE of Park Co. line, SE of Meeteetse, thin soil, roadside, *Sarcobatus, Artemisia* scrub, cactus, 6 Jul 1985, *Eckel 223686* (BUF, RM); 12 Jun 1990, *Parsons s.n.* (BUF, RM). Niobrara Co.: on US 85, ca. 5000 ft, 17 mi N of jct with WY 270, road to Lance Creek, N slope, open soil, *Melilotus officinalis,* cactus, *Artemisia*, short grasses, *Tortula ruralis*, 10 Jul 1985, *Eckel 871101* (BUF). Platte Co.: *Eckel 1320386* (RM, BUF). Sublette Co.: on US 191 (187), 9 mi N of border with Sweetwater Co., open ca. N-facing slope, bunched grasses, sage, shadscale, saltbush, 5 Jul 1985, *Eckel 961251* (BUF, RM).

Sweetwater Co.: on US (187) 191, 14-Mile Reservoir, US Dept. Interior, picnic area above pond and brook, dry slope, *Sarcobatus* and *Artemisia tridentata* scrub, with *Tortula mucronifolia, Pterygoneurum,* 5 Jul 1985, *Eckel 118186* (RM).

Note this species can be tiny, minute and muticous. It differs from *Syntrichia chisosa*, not yet found in Wyoming, by its revolute leaf margins. *Syntrichia chisosa* also has leaflike propagulae in the leaf axils. When *S. caninervis* is miniscule, note its typical *Syntrichia* character of vivid hyaline median basal cells in sharp contrast with the rich red-green brown of the upper lamina—this is in contrast with other tiny mosses such as *Aloina, Crossidium, Didymodon brachyphyllus*, etc.

Syntrichia norvegica F. Weber, Arch. Syst. Naturgesch. 1(1): 130, plate 5, fig. 1. 1804.
Barbula aciphylla B.S.G.
Barbula rufipila Card. & Thér.
Syntrichia norvegica Web. in Web. & Mohr
Tortula norvegica (Web.) Wahlenb. ex Lindb.
Tortula ruralis var. *alpina* Wahlenb.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007) but the state is within the range of the species. (As *Tortula norvegica*) In all states and provinces of the Pacific Northwest; Yukon, California, Nevada, Utah, Colorado; Manitoba, Ontario. (As *Tortula aciphylla* Bruch & Schimp.) Mammoth, Yellowstone Natl Park (*Smiy*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Tortula norvegica*) Albany Co.: 8000 ft, *Hermann 17720* (RM); crevices in vertical face of granite bluff on Sand Lake Rd., 1.3 mi NW of Route 130, 8500 ft, 3 mi W of Centennial, *Hermann 17749* (RM); Laramie Mountains, Roger Canyon, 8 air mi NE of Laramie city center, 7850–8000 ft, on thin soil over limestone boulder, 7 Jun 1993, *Miller 10241* (NYS). Johnson Co.: *Eckel 34586* (MO). Park Co.: 3200 m, *Weber B–44311* (COLO, RM); 6400–6600 ft, *Nelson 12563* (BUF, RM); 6458 ft, *Nelson 12382* (BUF, RM). Sheridan Co.: 4800 ft, *Hartman 10645* (RM, BUF); 5400 ft, *Hartman & Odasz 9403* (RM); dry soil, base granite rocks, Big Goose Creek, 2 Mar 1934, *Rollins 384,* c.fr. (RM). Sublette Co.: moist exposed spruce root on W shore of Lower Green River Lake, 7950 ft, Wind River Range, 50 mi N of Pinedale, *Hermann 25326* (RM); Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 10,290 ft, 42°59'N, 109°34'W, on damp rock at edge of fen, 16 May 1989, *Andrus 7835* (BING). Teton Co.: 7000 ft, *Hermann 25549* (RM).

Syntrichia papillosissima (Coppey) Loeske, Hedwigia 49: 44. 1910.
Barbula papillosissima Coppey, Bull. Séances Soc. Sci. Nancy, sér. 3, 8: 314, plate 2, figs. f, g. 1908.
Barbula ruralis var. *hirsuta* Vent.
Tortula papillosissima (Copp.) Broth.
Tortula ruralis var. *hirsuta* (Vent.) Paris

Not reported for Wyoming by FNA (FNA Vol. 27, 2007) although the state occurs within the range of the species. (As *Tortula papillosissima*) PARK CO.: 6458 ft, *12381* (BUF, RM); *13071* 6,000 ft (BUF, RM).

[*Syntrichia princeps* (De Not.) Mitt., J. Proc. Linn. Soc., Bot., suppl. 1: 39. 1859, excluded.]
Tortula princeps De Not., Mem. Reale Accad. Sci. Torino 40: 288. 1838.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007). (As *Tortula princeps*) Hat Six Falls, Carbon County (*Nelson 5034*); Sundance, Crook Cos. (*Nelson 2181*), Porter (1935).

R.H. Zander (pers. comm.) determined a specimen at RM labeled *Tortula princeps* as *Syntrichia ruralis* instead (*Nelson 2181*, Jul 3 1896), this specimen is not synoicous, it has no central strand in the stem; in all other respects it is *S. ruralis*. A specimen at RM (*Hermann 17844*) det. as *T. princeps* was also det. as *S. ruralis*, also *Nelson 5034* (RM), Aug 7 1898 (RM) (as *T. princeps*). Since I have only Porter's report, presumably based on the Carbon and Crook specimens redetermined as *S. ruralis*, I exclude this species from the moss flora of Wyoming.

Syntrichia ruralis (Hedw.) F. Weber & D. Mohr, Index Mus. Pl. Crypt., (2). 1803.
Barbula ruralis Hedw., Sp. Musc. Frond., 121. 1801.
Barbula laeviuscula Kindb. in Macoun
Syntrichia ruraliformi (Besch.) Dixon
Tortula ruraliformi (Besch.) W. Ingham
Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb

(As *Tortula ruralis*) Wyoming: Yellowstone Natl Park, Grand Canon, "6000 ped. alt. ster. (1449–52) (Roell 1893). (As *Tortula ruralis*) In all states and provinces of the Pacific Northwest; Alaska, Yukon, California, Nevada, Utah, Arizona, New Mexico, Colorado; widespread in the Middle W and in eastern North America. Common in dry situations, Albany, Carbon, (Johnson), Sublette, Sweetwater, Teton Cos., (Yellowstone Natl Park), Porter (1935). "Common in front of glaciers," Teton Range, Grand Teton Natl Park, Wyoming (Spence 1981). Teton Co., Spence (1985). Campbell Co., Medina (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

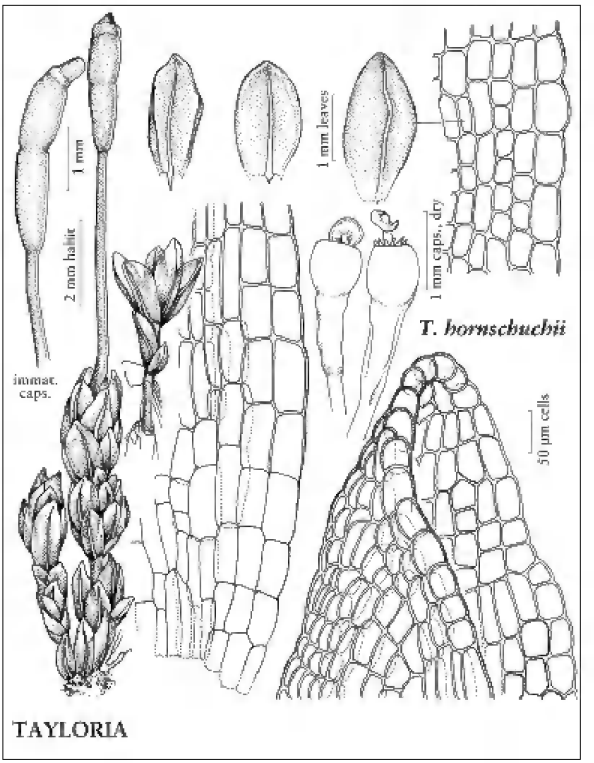
(All as *Tortula ruralis*) Albany Co.: *Eckel 871105* (BUF); ca. 4 mi SE of Centennial, NW base of Sheep Mountain along WY 11, ca. 7800 ft, sandstone outcrops and Chugwater Red Beds, with *Cerocarpus, Artemisia*, and *Amelanchier*, on soil beneath shrubs, 7 Jun 1993, *Miller 10262* (NYS). Big Horn Co.: Big Horn Mts., 28.5 air mi E Greybull 19.5 mi NNE Hyattville, fruit old, dehisced, with *Bryum lisae* var. *cuspidatum*, 9200 ft, 9 July1979, *Nelson 3344* (RM). Carbon Co.: 7 Aug 1898, *Nelson s.n.,* (as *Tortula princeps*) (RM). Crook Co.: 3 Jul 1896 *Nelson s.n.,* (as *Tortula princeps*) (RM). Crooke Co.: *Eckel 319686* (RM, BUF). Fremont Co.: 10,300 ft, *Rolston 86027* (CSU); rotten wood and dry soil, Brooks Lake, To-Gwo-Tee Pass, *Porter 1613* (RM); Bridger-Teton Natl Forest on US26 & US287, between Moran & Dubois, ca. 9000 ft, alpine meadow, wet with flowing streams, granite outcrops, with *Encalypta vulgaris* var. *rhabdocarpa*, *Bryum caespiticium*, 6 Jul 1985, *Eckel 93081103* (BUF, RM). Goshen Co.: Fort Laramie Natl Historical Site, on WY 160 off US 160, 4230 ft, open kept lawn, in soil around low shrubs, some seepage, gentle slope, 4 Aug 1984, *Eckel 412386* (BUF, RM). Laramie Co.: *Eckel 1123686* (RM, BUF). Lincoln Co.: on US 189 S at jct. with US 30, Diamonville town limits, ca. 6927 ft, rocky dry gully in hillside, *Sarcobatus vermiculatus*, shadscale, *Artemisia tridentata*, Sego lily, *Opuntia,* calcareous fine soil, with *Desmatodon systylius, Eckel 94082201* (BUF). Niobrara Co.: 5000 ft, *Eckel 871103* (BUF). Park Co.: 5000 ft, xeric, with lichens, 4 Apr 1988, *Vukelich s.n.*(BUF); granite outcrop on bank of Crandall Creek, 6500 ft, 19 Jul 1965, *Hermann 20037*, c.fr., calyptra falling away, c. opercula (RM). Platte Co.: *Eckel 1220386* (RH). Sheridan Co.: *Hartman 10735* (RH, BUF); 6600–8000 ft, *Odasz 1126* (BUF, RM); *Odasz 1144* (BUF, RM). Sublette Co.: on US 191, 21 mi N of border with Sweetwater Co., soil, with bunched grasses, sage, shadscale, saltbush, soil under *Artemisia,* 5 Jul 1985, *Eckel 961252,* with *Tortula caninervis* (BUF, RM). Weston Co.: outskirts N of Newcastle on US85, near base of low hill above grassy scrub, arid woodland of *Pinus contorta, P. ponderosa, Juniperus,* shaded, with *Grimmia plagiopodia*, 10 Jul 1985, *Eckel 723686* (BUF). Yellowstone Natl Park: low meadow along pond, 7700 ft, N shore of Yellowstone Lake, *Hermann 20018* (RM); Lost Lake outlet, 1 Sept 1948, *Conard s.n.* (BUF); Main Hot Spring, calcareous soil, 22 Jul 1980, *Zander & Eckel s.n.* (BUF).

(As *Tortula ruraliformis*) Park Co.: 6400–6600 ft, *Hartman 12563* (BUF, RM). Sheridan Co.: 6500 ft, *Hartman 10732* (RM, BUF).

TAYLORIA Hook., J. Sci. Arts (London) 2(3): 144. 1816. (Splachnaceae)

Tayloria acuminata Hornschuch, Flora 8: 78. 1825.
Tayloria serrata subsp. *acuminata* (Hornschuch) J.J. Amann
Tayloria splachnoides subsp. *acuminata* (Hornschuch) Kindb.
Tayloria splachnoides var. *acuminata* (Hornschuch) Huebener

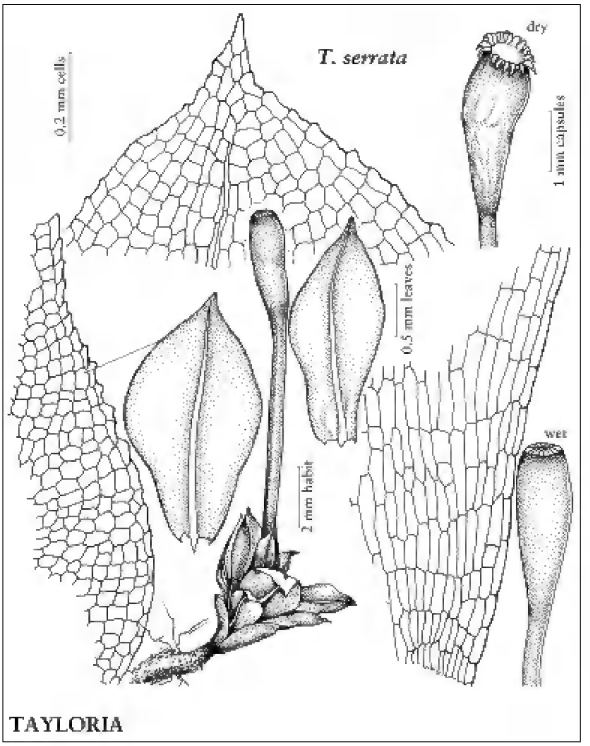
Wyoming (FNA 28, 2014). Crum & Anderson (1981).



Courtesy FNA Association, FNA 27, 2007

Tayloria hornschuchii (Greville & Arnott) Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 216(I,3): 502. 1903.
Dissodon hornschuchii Grev. & Arnott, Mem. Wern. Nat. Hist. Soc. 5: 468, plate 13, figs. 34–38. 1826.

Wyoming (FNA 28., 2014).



Courtesy FNA Association, FNA 28, 2014

Tayloria ligulata (Dickson) Lindb., Musc. Scand. 19. 1879.
Splachnum lingulatum Dickson, Fasc. Pl. Crypt. Brit. 4: 4, plate 10, fig. 6. 1801.
Weissia turbinata Drumm.

Not reported for Wyoming in FNA (FNA 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: subalpine, 2900 m, *Weber B–44275* (COLO, RM) (NY, Buck, in litt.)

Tayloria serrata (Hedw.) P. Bruch & W.P. Schimper, Bryol. Europ. 3: 204. 1844.
Splachnum serratum Hedw., Sp. Musc. Frond., 53, plate 8, figs. 1–3. 1801.

Not reported for Wyoming in FNA (FNA Vol. 28, 2014).

Yellowstone Natl Park: 4 mi SE of Old Faithful and W of Divide, on damp soil, 29 Aug 1951, *Welch 14864,* c.fr. (NY); on wet clay, same locale, etc., *Welch 14863* (NY).

The leaves of this species resemble those of *Physcomitrium*, large and lax with blunt teeth along the margins, in this specimen strongly obovate with a sharp, reflexed cusp at the apex. The fruit is critical in determining this species.

TETRAPHIS Hedw., Sp. Musc. Frond., 43. 1801. (Tetraphidaceae)
Georgia Müll. Hal.

Tetraphis pellucida Hedw., Sp. Musc. Frond., 45, plate 7, fig. 1a–f. 1801.
Georgia pellucida (Hedw.) Rabenh.
Tetraphis cuspidata (Kindb.) Paris

Wyoming (FNA Vol. 28, 2014). "In all states ... of the Pacific Northwest ... widespread in the Middle West ..." Jenny Lake Teton Co. (*Porter 1225*), Porter (1935). Teton Co., Spence (1985).

Teton Co.: 7000 ft, Aug 29 1973, *Hermann 25571*, c.fr. (RM).

Var. **pellucida**

Wyoming (FNA Vol. 28, 2014)

Var. **trachypoda** (Kindb.) J. Harpel, Sida 22: 551. 2006.
Georgia trachypoda Kindb., Rev. Bryol. 20: 93. 1893.

Wyoming (FNA Vol. 28, 2014).

THUIDIUM Schimper in P. Bruch and W.P. Schimper, Bryol. Europ. 5: 157, plates 481–486. 1852. (Thuidiaceae)

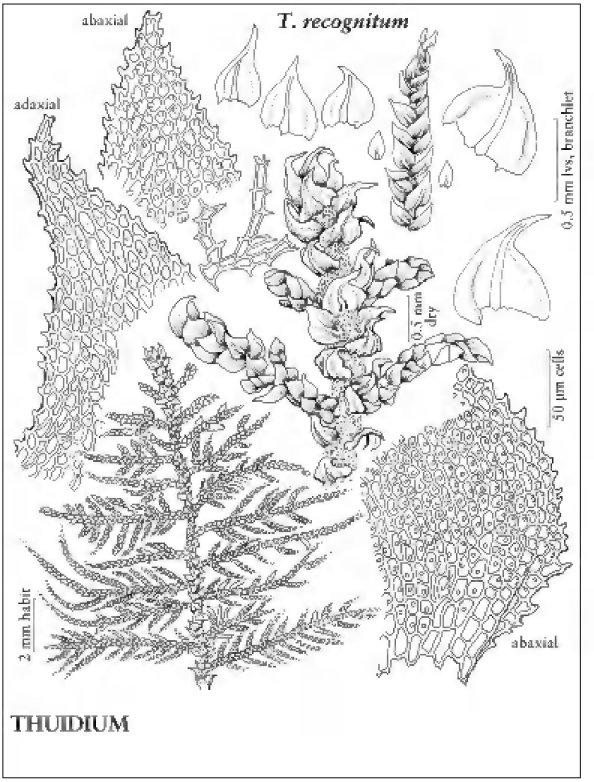
Thuidium abietinum (Hedw.) Schimp. in B.S.G. = Abietinella abietina (Hedw.) Fleisch.

Thuidium recognitum (Hedw.) Lindb., Not. Sällsk. Fauna Fl. Fenn. Förh. 13: 416. 1874 (as Thuyidium).
Hypnum recognitum Hedw., Sp. Musc. Frond., 261. 1801.
Hypnum protensum Michaux

Not reported for Wyoming by FNA (FNA Vol. 28, 2014). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: SNF, Beartooth Plateau, Lily Lake shore, wet spruce forest, on wet litter and humus, 44°56.880–890'N, 109°42.930–940'W, ca. 7700 ft (2350 m), 17 Aug 2008, *Kosovich-Anderson 3047* (COLO, MO).

The absence of this species "from western North America is nearly complete except for an arc of distribution that extends from eastern North America into the high Arctic thence southward in the mountains from Alaska and British Columbia barely reaching Washington State" (Norris & Shevock 2004). From an ecological community that "is generally characterized by high bryophyte diversity and abundance, creating for Wyoming an unusual picture of a northern boreal forest with bryophyte coverage up to 100%, dominated by typical luxuriant forms of *Hylocomium splendens* combined with *Aulacomnium palustre, Climacium dendroides, Helodium blandowii, Rhizomnium* spp., *Thuidium recognitum, Marchantia alpestris*, and others," Kosovich-Anderson & Weber (2011).



Courtesy FNA Association, FNA 28, 2014

TIMMIA Hedw., Sp. Musc. Frond., 176. 1801. (Timmiaceae)

Timmia austriaca Hedw., Sp. Musc. Frond., 176, plate 42, figs. 1–7. 1801.
Timmia arctica Kindb.
Timmia austriaca var. *arctica* (Kindb.) Arnell
Timmia austriaca var. *brevifolia* Ren. & Card.
Timmia austriaca var. *papillosa* Hesselbo.
Timmia polytrichoides var. *lutescens* Brid.

Wyoming (FNA Vol. 27, 2007). Wyoming: Yellowstone Natl Park, sterile (1526) (Roell 1893). Laramie Peak, Albany County (*Nelson 1645*); Brooklyn Lake, Albany County (*Nelson 5174*); Wolf Creek, Sheridan County (*Nelson 2324*). Carbon, Crook: (as var. *brevifolia*) R. & C., Tower Falls, Yellowstone Natl Park (*Nelson 5913*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: Aug 1897, *Nelson 22* (RM); 8500 ft, *Hermann 17779* (RM). Big Horn Co.: *Nelson 4543* (RH, BUF); 7200 ft, Big Horn Mtns., ca. 33.5 mi ESE of Greybull, ca. 11.5 mi NE of

Hyattville, S of Paint Rock Lakes, under Engelmann spruce-subalpine fir, 8600 ft, 9 Aug 1979, *Nelson 4942* (RH, BUF). Carbon Co.: 9000 ft, *Hermann 17801* (RM). Fremont Co.: 8400 ft, *Hermann 25514* (RM). Johnson Co.: (var. *brevifolia*) 5600–6000 ft, *Odasz 1261* (BUF, RM). Park Co.: 6000 ft, 1 Apr 1988, *Vukelich s.n.* (BUF); (var. *brevifolia*) 6800–7400 ft, *Herman 22063,* c.fr. (BUF, RM). Sheridan Co.: 12 Jul 1896, *Nelson s.n.* (RM); 5200–7200 ft, *Odasz 1029,* (BUF, RM); (var. *brevifolia*) 5200–7200 ft, *Odasz 1030* (BUF, RM). Sublette Co.: *Hermann 25332* (RM). Washakie Co.: (var. *brevifolia*) Big Horn Mts; along Canyon Creek ca. 6.7 mi W of Hazelton Pyramid, mixed conifer forest, 8000 ft, 17 Aug 1980 *Nelson & Fonken 7315* (BUF, RM). Yellowstone Natl Park: *Nelson & Nelson 5913* (RM).

Var. *brevifolia* is not recognized in the Anderson et al. (1990) checklist. One probably should not recognize var. *brevifolia:* all specimens seen appear to be between 4 and 6 mm in leaf length: perhaps this is the typical size. *Timmia megapolitana* in the field resembles more a *Polytrichum* with rather erect, non-contorted leaves, which are inrolled. *Polytrichum* has multicellular filaments on the costa and a tympanum across the mouth of the capsule. *Timmia* has peristome teeth with an inner peristome of 64 cilia; the capsules are inclined.

Timmia megapolitana Hedw., Sp. Musc. Frond., 176. 1801.

Wyoming (FNA Vol. 27, 2007); note the subsp. *megapolitana* is not reported for Wyoming by FNA Vol. 27, 2007. Wood's Creek, Albany Co. (*Porter 670*); Beaver Creek, Weston County (*Nelson 9459*), Porter (1935). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

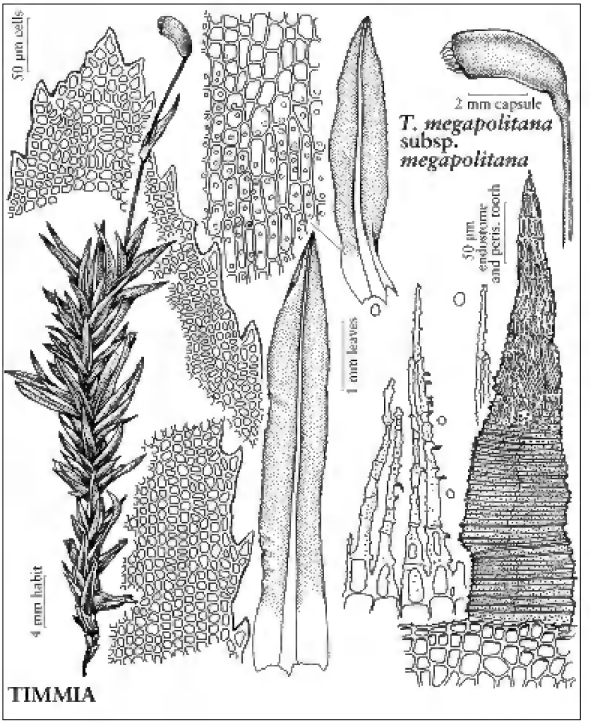
Albany Co.: *Eckel 871111* (RM, BUF); Laramie Mtns, Roger Canyon, ca. 8 mi NE of Laramie, limestone outcrops with *Cercocarpus montanus,* 7 Jun 1993, *Buck 23153,* c.fr., young, lid fast shut (NY); along Roger Canyon in the Laramie Mtns, 7 mi due NE of Laramie city center, *Artemisia* scrub vegetation, limestone cliffs and outcrops, ca. 7600 ft, on limestone cliff, 7 Jun 1993, *Reese 18148* (LAF). Sheridan Co.: 6600–8000 feet, *Odasz 1132* (BUF, RM); Big Horn Mts., forested valley through Chugwater redbeds, limestone outcrops, and forest margin, 4800 ft, 3 Aug 1979 *Hartman 10649*, c.fr. (BUF, RM).

subsp. **megapolitana.**
Timmia cucullata Michaux

subsp. **bavarica** (Hessler) Brassard, Lindbergia 10: 34. 1984.
Timmia bavarica Hessler, De Timmia 19, fig. 3. 1822.
Timmia megapolitana var. *bavarica* (Hessler) Brid.

Wyoming (FNA Vol. 27, 2007). (As *Timmia bavarica* Hesel.) The common species in the southern part of the State. Telephone Canyon, Albany Co. (*Porter 1456*); Pole Mountain, Albany County (*Porter 666*); Rogers Canyon, Albany County (*Porter 670*), Porter (1935).

Albany Co.: 8500 ft, *Hermann 17757 1/2* (RM); Laramie Mountains, Roger Canyon, 7 mi NE of Laramie city center, limestone outcrops with *Cerocarpus montanus, Artemisia cava, A. tripartita, A. nova, A. tridentata,* aspen grove below bluff, on soil, 7 Jun 1993, *Miller 10237* (NYS). Big Horn Co.: Big Horn Mts., 8600–8800 ft, on limestone, *Odasz 731*, c.fr. (BUF, RM). Park Co.: 6900–7800 ft, *Hartman 21049*, c.fr. (BUF, RM); 6900–7800 ft, *Hartman 21026,* c.fr. (BUF, RM). Sheridan Co.: 8400 ft, *Nelson & K. Dueholm 3757* (RM, BUF).



Courtesy FNA Association, FNA 27, 2007

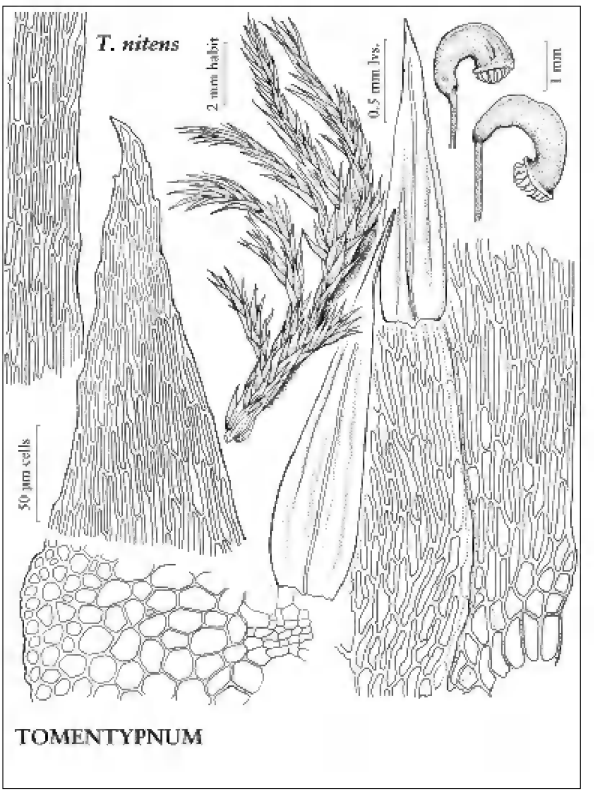
TOMENTYPNUM Loeske, Deutsche Bot. Monatsschr. 22: 82. 1911. (Amblystegiaceae) (note: not Tomenthypnum)
Camptothecium sect. Tomentella Kindb.
Homalothecium subg. *Tomentypnum* (Loeske) H. Robinson

Tomentypnum nitens (Hedw.) Loeske, Deutsche Bot. Monatsschr. 22: 82. 1911,
Hypnum nitens Hedw., Sp. Musc. Frond., 255. 1801,
Camptothecium nitens (Hedw.) Schimp.
Homalothecium nitens (Hedw.) H. Robinson
Tomentypnum nitens var. *involutum* (Limpr.) C.E.O. Jensen,

Wyoming (FNA Vol. 28, 2014). Wyoming (Lawton). (As *Camptothecium nitens* (Schreb.) Schimp. sec. Crum et al. (1973). (As *Camptothecium nitens* (Schreb.) Schimp.) Albany County (*Porter 937, 942* & *1421*), Porter (1935). Johnson Co., in association with *Warnstorfia tundrae,* Lenz (2006). Sublette Co., Cooper & Andrus (1994). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Park Co.: calcareous bog, 6700 ft, *Hartman 18547* (RM); Beartooth Plateau, 2900 m, *Weber B–44285* (COLO, RM); Beartooth Lake, S slope, alt. 9000 ft, boggy area, *Whitehouse 27444* (US);

wet soil, in calcareous white spruce fen at base of Cathedral Cliffs, 2 mi E of Crandall Ranger Station, 6600 ft, 12 Aug 1990, *Elliott 1730* (BUF). Sheridan Co.: on vertical rock face, moist limestone, Big Horn Natl Forest, 16 Jun 1992, *McKee 92–019,* with *Encalypta vulgaris* var. *vulgaris* (RM). Sublette Co.: Bridger Wilderness, Wind River Range, Barnes Lake, 9747 ft, 42°57'30"N, 109°36'W, mineralized seeps at south end of lake, 14 May 1989, *Andrus 7794* (BING).



Courtesy FNA Association, FNA 28, 2014

TORTELLA (Lindb.) Limpr., Laubm. Deutschl. 1: 599. 1888, name conserved. (Pottiaceae)
Mollia subgen. *Tortella* Lindb., Musc. Scand., 21. 1879.

Tortella alpicola Dixon, Ann. Bryol. 3: 54. 1929.
Tortella fragilis var. *tortelloides* (S. W. Greene) R.H. Zander & Hoe
Tortella tortelloides (S. W. Greene) H. Robinson

Wyoming (Eckel 1997). (All as *Tortella tortelloides:*) Fremont Co.: limestone outcrop, Douglas fir slope, 1/2 mi E of Horse Creek Campground, 7800 ft, Absaroka Range, 11 mi N Dubois, 28 Aug 1973, *Hermann 25530* (with *Pseudoleskella tectorum, Gymnostomum aeruginosum* (WTU). A duplicate specimen of *Hermann 25530* in RM did not contain a specimen of *T. alpicola*. Sheridan

Co.: moist limestone, on vertical rock face with *Trentepolia* (agla), Bighorn Natl Forest, 16 Jun 1992, *McKee 92–018* (BUF, RM); same area, in crevices of rock ridge faces, limestone, 24 Jun 1992, *McKee 92–046,* with *Encalypta vulgaris, Mnium blyttii, Orthotrichum jamesianum, Pseudoleskeella tectorum, Tortula norvegica, Tortula mucronifolia* (BUF, RM).

Tortella fragilis (Hook.& Wils.) Limpr., Laubm. Deutschl. 1: 606. 1888.
Didymodon fragilis Hook. & Wils. in T. Drumm., Musc. Amer., 127. 1828 (as fragile).
Barbula fragilis (Hook. & Wils.) B.S.G.
Mollia fragilis (Hook. & Wils.) Lindb.

Wyoming (FNA Vol. 27, 2007). British Columbia, Washington, Alberta, Montana, Wyoming; Alaska, Nevada; Iowa, Minnesota, Michigan, Ontario; Greenland, Quebec, New England, New Jersey. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Albany Co.: 10,000 ft, Medicine Bow Mts., *Hermann 17222* (NY, RM); along Roger Canyon, Laramie Mtns., 7 mi due NE of Laramie, Artemesia scrub, limestone cliffs, 7600 ft, crack in limestone cliff, *Reese 18163A* (LAF, BUF); thin soil on low basalt boulder, shore of rocky pond 1 mi S of Brooklyn Lake, 10,000 ft, Snowy Range, Medicine Bow Mts, 9 mi W of Centennial, 22 Aug 1961, *Hermann 17222* (MICH); Medicine Bow Natl Forest, Snowy Range, Libby and Lewis Lakes vicinities (near Sugarloaf Campground area), slope facing the north, alpine tundra, on open dry gravelly soil, associated with *Encalypta* sp., 10,800 ft, 16 Sep 2007, *Kosovich-Anderson 1604* (MO). Park Co.: 3250 m, *Weber B–44263* (COLO, RM) Beartooth Plateau, Cooke City to Red Lodge Highway, alpine bogs of E summit, E slope, head of Wyoming Creek, 3250 m (COLO); W of Bear Tooth Butte, Crazy Creek campground, 22 Aug 1963, *Lawton 2027* (NY, WTU); Beartooth Plateau, Cooke City to Red Lodge Hwy alpine bogs of E summit, E slope, head of Wyoming Creek, 3250 m, 19 Aug 1973, *Weber B- 44263* (COLO). Teton Co.: Hidden Falls along the E shore of Jenny Lake, on soil near falls, 6600–7100 ft, 12 Aug 1962, *Redfearn 11713* (MO).

Tortella humilis (Hedw.) Jennings, Man. Mosses W. Pennsylvania, 96. 1913.
Barbula humilis Hedw., Sp. Musc. Frond., 116, plate 25, figs. 1–4. 1801.
Barbula caespitosa Schwägr.
Tortella caespitosa (Schwägr.) Limpr.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007). Teton Co., Spence (1985).

This appears to be an eastern species, but is provisionally accepted based on the report of Spence (1985).

Tortella tortelloides (S. W. Greene) H. Robinson = Tortella alpicola Dixon

Tortella tortuosa (Hedw.) Limpr., Laubm. Deutschl. 1: 604. 1888.
Tortula tortuosa Hedw., Sp. Musc. Frond., 124. 1801.

Var. **tortuosa**
Barbula tortuosa (Hedw.) Web. & Mohr
Mollia tortuosa (Hedw.) Lindb.
Trichostomum tortuosum (Hedw.) Dix.

Wyoming (FNA Vol. 27, 2007). In all states and provinces of the Pacific Northwest; Alaska, Nevada, Utah, Colorado; South Dakota, Minnesota, Michigan, Ontario; Nova Scotia and Quebec to

North Carolina. Hoback Canyon, Teton Co. (*Porter 1166 & 1169*), Porter (1935). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

Crook Co.: Black Hills: 6.4 km N-NE of Warrens Peaks, along Beaver Creek, *Betula-Pinus* woods, rather exposed on soil covered rock, 21 May 1977, *Churchill 8734b* (MO). Sheridan Co.: 6600–8000 ft, *Odasz 1172* (BUF, RM); 6600–8000 ft, T58N, R90W Sec. 30, *Odasz 1084* (MO, RM). Park Co.: Beartooth Plateau, Cooke City to Red Lodge Highway, alpine bogs of E summit, E slope, head of Wyoming Creek, 3250 m, 19 Aug 1973, *Weber B- 44263,* as *T. arctica* (MO).

TORTULA Hedw., Sp. Musc. Frond., 122. 1801, name conserved. (Pottiaceae)
Desmatodon Brid.
Phascum Hedw.
Pottia (Reichenbach) Fürnrohr
Protobryum J. Guerra & M. J. Cano

Tortula caninervis (Mitt.) Broth. = Syntrichia caninervis Mitt.

Tortula cernua (Huebener) Lindb., Musc. Scand., 20. 1879.
Dermatodon (sic) *cernuus* Huebener, Muscol. Germ., 117. 1833 .
Cynodontium latifolium Schwaegr.
Desmatodon camptothecius Kindb. in Macoun
Desmatodon cernuus (Hüb.) P. Bruch & Schimp. in B.S.G.
Tortula cernua (Hüb.) Lindb.

Wyoming (FNA Vol. 27, 2007). (As *Desmatodon cernuus*) British Columbia, Alberta, Montana, Wyoming; Yukon, Nevada, Utah, Colorado; Manitoba, Wisconsin, Ontario; Greenland, Newfoundland, Quebec, Ohio. Wyoming, Flowers (1973). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(All as *Desmatodon cernuus*) Albany Co.: 8500 ft, 17 Aug 1961, *Hermann 17105,* c.fr. (RM); northwest base of Sheep Mtn. along Wy Rte. 11, ca. 4 mi due ESE of Centennial, ca. 7750 ft, fen with low forest of *Populus, Betula, Salix* in shallow water, a "hanging bog" on steep hillside, hummock under trees, 7 Jun 1993, *Reese 18175,* with *Desmatodon cernuus* (LAF). Yellowstone Natl Park: Lower Falls, Yellowstone River, 21 Aug 1938, *Bartley & Pontious s.n.* (RM); Soda Butte, 19 Aug 1953, *Lawton 1905,* c.fr. (WTU).

This species looks much like a *Bryum* because of the large, thick walled, square to short rectangular, smooth upper cells, the apiculus or cusped leaf tip, and especially the leaf border. The capsule is zygomorphic, however, and the teeth were coarsely papillose and pronged—unlike the delicate teeth with their sprinkles of minute papillae of *Bryum*.

Tortula guepinii (P. Bruch & W.P. Schimper) Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 214(I,3): 430. 1902.
Desmatodon guepinii P. Bruch & W.P. Schimper, Bryol. Europ. 2: 58, plate 133. 1843.

Wyoming (FNA Vol. 27, 2007).

(As *Desmatodon guepinii)* Park Co.: 6400–6600 ft, *12567* (BUF, RM).

Tortula guepinii is smaller than *T. hoppeana*, with leaves less than 2 mm, "and cells of the leaf margin are distinctly less papillose at the apex" (Zander & Eckel, FNA Vol. 27, 2007).

Tortula hoppeana (Schultz) Ochyra, Bryologist 107: 499. 2005.
Trichostomum hoppeanum Schultz in C. F. Hornschuch, Syll. Pl. Nov 2: 140. 1828.
Bryum piliferum Dicks.
Desmatodon glacialis Funck ex Brid.
Desmatodon latifolius (Hedw.) Brid.
Desmatodon latifolius var. *muticus* (Brid.) Brid.
Desmatodon latifolius var. *muticus* (Brid.) Brid.
Desmatodon latifolius var. *pilifer (*Dicks.) Rabenh.
Dicranum latifolium var. *muticum* Brid.
Tortula eucalyptrata Lindb.
Trichostomum euryphylla R.H. Zander

Wyoming (FNA Vol. 27, 2007). *(*As *Desmatodon latifolius)* Washington, Oregon, Alberta, Idaho, Wyoming; California, Nevada, Colorado; Quebec. In all states and provinces of the Pacific Northwest; Alaska, California, Arizona, Nevada, Utah, Colorado; Quebec. (As *Desmatodon latifolius* var. *glacialis* Schimp.) Nash's Fork, Albany County (*Nelson 7810*); Brooklyn Lake, Albany County (*Nelson 1835*) and *Nelson 5234*); Bridger Peak, Carbon Co. (*Goodding 1965*). *Nelson 5234* was determined by Holz. as *Barbula amplexa* Lesq., and was so reported by Dr. Nelson (1900). "Mr. E.B. Bartram is to be thanked for the correction," Porter (1935). "Common in front of glaciers", Teton Range, Grand Teton Natl Park, Wyoming, (Spence 1981). Teton Co., Spence (1985). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

No county, *Nelson 2865b* (RM). Carbon/Albany Co.: *Nelson 7810* (RM). Albany Co.: Nash's Fork, under spruce trees, 9000 ft, 29 Jul 1900, *Nelson 7810*, c.fr., & calyptrae (TENN); La Plata Mines, 10,000 ft, on soil, in wet places, *Nelson 5234* (muticous form) (TENN). Carbon Co.: Medicine Bow Mts., 9600–10,000 ft, *Hermann 20730* (RM, BUF); rotted wood in soil in lodgepole pine woods along Trail Creek, Sand Lake Rd., 9000 ft, Medicine Bow Mts., 4.5 mi SW Morgan, 6 Aug 1962, *Hermann 17813,* c.fr., (WTU), Medicine Bow Mts., 2.3 mi above French Creek, 11 Aug 1953, *Lawton 1705,* c.fr., (WTU); *Hermann 17187* (RM); Nash's Fork, Medicine Bow Mts., *Nelson 7810* (RM). Park Co.: road from Bear Tooth Lodge to Red Lodge, E of summit near small glacial lake at 10,500 ft, 21 Aug 1953, *Lawton 1967,* c.fr. (WTU). Sublette Co.: Bridger Wilderness, Wind River Range, near Bell Lakes, 10,100 ft, 42°58'N, 109°35'W, with *Polytrichum juniperinum, Bryum pseudotriquetrum*, *Pohlia nutans,* 16 May 1989, *Andrus 7861* (BING).

Tortula inermi (Brid.) Mont., Arch. Bot. (Leipzig) 1: 136. 1832.
Syntrichia subulata var. *inermi* Brid., Bryol. Univ. 1: 581. 1826.
*Syntrichia inermi (*Brid.) Bruch

Wyoming (FNA Vol. 27, 2007). Wyoming; California, Arizona, Utah. Wyoming, Flowers (1973). Dry limestone rock crevices, Telephone Canyon, Albany Co. (*Porter 1272*), Porter (1935).

Tortula leucostoma (R. Brown) Hook. & Grev., Edinburgh J. Sci. 1: 294. 1824.
Barbula leucostoma R. Brown, Chlor. Melvill., 40. 1823.
Desmatodon leucostoma (R. Brown) Berggr.
Desmatodon obliquus B.S.G.
Desmatodon suberectus (Hook.) Limpr.
Tortula suberecta Hook. in Drumm.

Not reported for Wyoming in FNA (FNA Vol. 27, 2007). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).

(No county): Big Horn Natl Forest, Prune Creek, 30 Aug 1951, *Whitehouse s.n.* (WTU). Sublette Co.: on steep, gravelly, peaty open slope above W shore of Lower Green River Lake, 7950 ft, Wind River Range, 50 mi N of Pinedale, 19 Jun 1973, *Hermann 25339,* c.fr. (WTU).

Tortula mucronifolia Schwägr., Sp. Musc. Frond. Suppl. 1(1): 136, plate 34. 1811.

Wyoming (FNA Vol. 27, 2007). British Columbia, Alberta, Idaho, Montana, Wyoming; Alaska, Yukon, Arizona, New Mexico, Utah, Colorado; Minnesota, Iowa, Ontario; Greenland, New England, New York. Albany, Carbon cos., Yellowstone Natl Park, Porter (1935). Campbell Co., Medina (1994).

Albany Co.: dry sandy soil, *Porter 1751* (RM); *Porter 1697 (*NY, RM); NW base of Sheep Mtn., sandstone outcrops and chugwater redbeds with *Artemisia* dominant, 7 Jun 1993, *Buck 23221*, fruit old, peristomes eroding (NY). Crook Co.: Devil's Tower Natl. Mon., open *Pinus ponderosa-Quercus* woods, 22 May 1977, *Churchill 8814*, c.fr. (NY). Park Co.: 6500 ft, *Hermann 20040 1/2* (RM). Sweetwater Co.: on US (187) 191, at 14 Mile Reservoir, picnic area, US Dept. of Interior, dry slopes above pond, *Sarcobatus, Artemisia tridentata* scrub, with *Pterygoneurum subsessile, T. caninervis*, 5 Jul, 1985, *Eckel 318186* (BUF). Sheridan Co.: 6500 ft, *Hartman 10735* (BUF, RM); 4,800 ft, *Hartman 10591* (BUF, RM).

Tortula norvegica (Web.) Wahlenb. ex Lindb. = Syntrichia norvegica F. Weber

Tortula obtusifolia (Schwägr.) Mathieu, Fl. Gén. Belgique 2: 48. 1853.
Barbula obtusifolia Schwägr., Sp. Musc. Frond. Suppl 1(1): 129, plate 31. 1811.
Desmatodon arenaceus Sull.
Desmatodon coloradensis Grout
Desmatodon obtusifolius (Schwaegr.) Schimp.

Wyoming (FNA Vol. 27, 2007). (As *Desmatodon obtusifolius*) British Columbia, Washington, Alberta, Montana, Wyoming; Alaska, Utah, Colorado, Arizona, New Mexico; South Dakota, Nebraska, Kansas, Texas, Manitoba, Minnesota, Iowa, Missouri, Wisconsin, Michigan, Indiana, Ontaro; Quebec, New Jersey, Ohio, Tennessee. Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010). (As *Desmatodon obtusifolius*) Weston Co., Wynne (1943).

Weston Co.: *Eckel 1023686* (RM, BUF). ? Co., Kofa Mts., *Goodding s.n.,* Mar 22, 1939 (RM).

Tortula papillosissima (Copp.) Broth. = Syntrichia papillosissima (Coppey) Loeske

Tortula princeps De Not. = Syntrichia princeps (DeNotaris) Mitt.

Tortula plinthobia (Sull. & Lesq.) Broth. in H.G.A. Engler and K. Prantl, Nat. Pfanzenfam. 214(I,3): 430. 1902.
Desmatodon plinthobius Sull. & Lesq. in A. Gray, Manual ed. 2, 628. 1856.

Not reported for Wyoming by FNA, although the state is within the range of the species and should be expected (FNA Vol. 27, 2007). (As *Desmatodon plinthobius*) Rochelle Hills, Campbell Co., Medina (1994).

[*Tortula porteri* (James) Broth. in H.G.A. Engler and K. Prantl, Nat. Pflanzenfam. 214(I,3): 430. 1902, excluded.]
Desmatodon porteri James in C.F. Aust., Musci Appalach., 123. 1870.
Desmatodon fisherae H.A. Crum

Not reported for Wyoming in FNA; the species occurs in eastern North America (FNA Vol. 27, 2007). (As *Desmatodon porteri*) Cummins, Albany Co. (*Nelson 1538*, in part), Porter (1937).

This distinctively Eastern species is very doubtfully a member of the Wyoming moss flora.

Tortula ruraliformi (Besch.) Ingh. = Syntrichia ruralis (Hedw.) F. Weber & D. Morr.

Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb. = Syntrichia ruralis (Hedw.) F. Weber & D. Morr.

Tortula systylia (Schimper) Lindb., Musc. Scand., 20. 1879.
Desmatodon systylius Schimper, Flora 28: 145. 1845.

Wyoming (FNA Vol. 27, 2007). (As *Desmatodon systylius)* Canadian Rocky Mountains, Wyoming; California; Newfoundland.

Lincoln Co.: on US 189 S at jct. with US 30, Diamonville town limits, ca. 6927 ft, rocky dry gully in hillside, *Sarcobatus vermiculatus*, shadscale, *Artemisia tridentata*, Sego lily, *Opuntia,* on calcareous fine soil, 4 Jul 1985, *Eckel 94082200,* c. fr., with *Tortula ruralis* (BUF, RM).

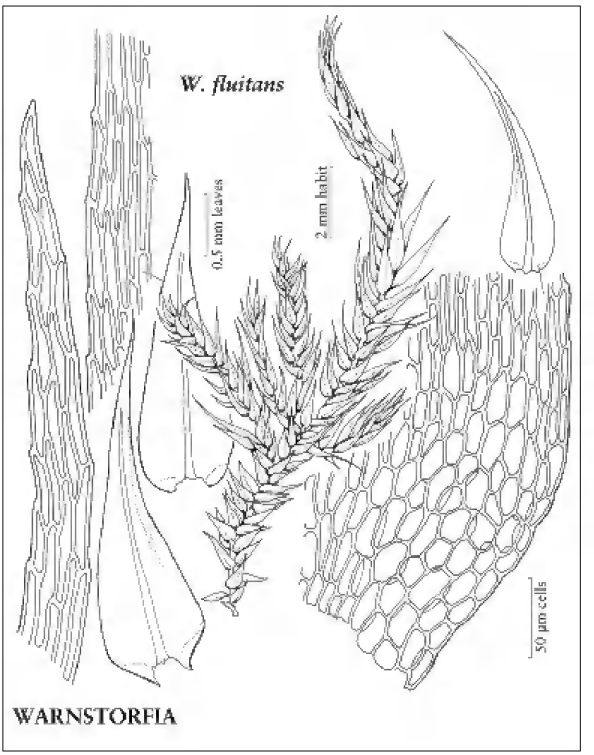
In the Lincoln Co. specimen, the capsule variation is strongly reminiscent of that of *Hennediella heimii*, the setae are some long, some short, the capsules are some broad and dark, others seem thin and light—perhaps this is just the last season and the present. The gametophytes when not bleached yellow-orange are a fresh green, bright because they are not papillose like *Pterygoneurum* species, which are more dull, sordid brownish orange and green. The latter genus often has rough awns: *D. systylius* has smooth awns. This species also has the distinctive areolation of the group, lax, thin-walled, with a gradual transition from basal cells to those of the limb—a more delicate overall appearance. "*Tortula systylia* may be confused with *Stegonia* but the latter has a distinct triangle of echlorophyllose cells at the apex of the much broader leaves. It is similar also to *T. hoppeana*, but the laminal cells (of *T. systylius*) are smooth" (Zander & Eckel, FNA Vol. 27, 2007).

TRICHOSTOMUM Bruch, Flora 12: 396. 1829, name conserved. (Pottiaceae)
Oxystegus (Limpr.) Hilpert.
Paraleptodontium D. G. Long
Trichostomum subg. *Crispuliformes* (Kindb.) R.H. Zander
Trichostomum subg. *Oxystegus* Limpr.

Trichostomum tenuirostre (Hook. & Taylor) Lindb., Öfvers. Kongl. Vetensk.-Akad. Förh. 21: 225. 1864.
Weissia tenuirostris Hook. & Taylor, Muscol. Brit. ed. 2, 83.
Didymodon trachyneuron Kindb.
Oxystegus cylindricus (Brid.) Hilp.
Oxystegus tenuirostris (Hook. & Tayl.) A. J. E. Smith
Trichostomum cylindricum (Brush ex Brid.) Müll. Hal.
Weissia cylindrica Bruch ex Brid.

Not reported for Wyoming by FNA (FNA Vol. 27, 2007). Crum and Anderson (1981: 303).

While thumbing through the first volume of the mosses of Eastern North America it was noticed that the chromosome number (n = 13) of this species was determined from a specimen from Wyoming (Crum & Anderson 1981: 303). The species has a disjunctive distribution between the east and western coasts of North America. It is reported from Colorado in "alpine tundra, and at compensating environments on north faces of lower canyon walls" (Weber & Wittmann 2007).



Courtesy FNA Association, FNA 28, 2014

WARNSTORFIA Loeske, Hedwigia 46: 310. 1907. (Calliergonaceae)

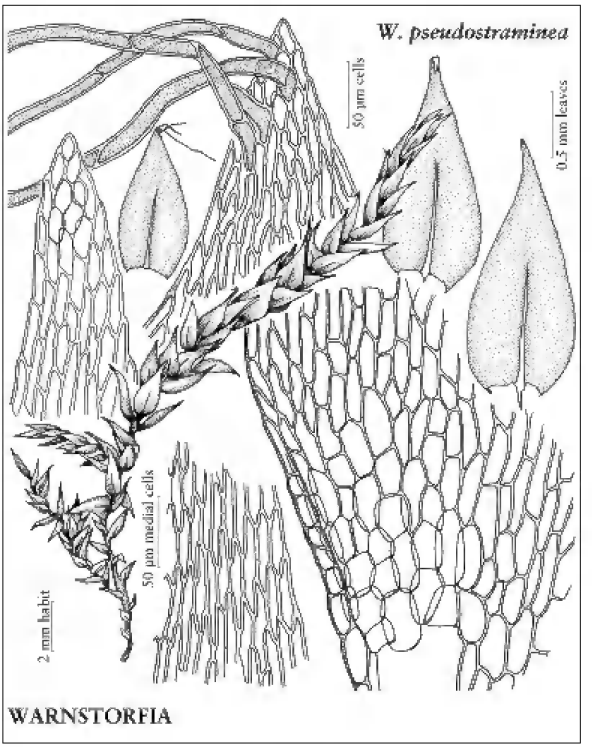
Warnstorfia exannulata (Schimp. in B.S.G.) Loeske = Sarmentypnum exannulatum (Schimper) Hedenäs

Warnstorfia fluitans (Hedw.) Loeske (Hedw.) Loeske, Hedwigia 46: 310. 1907.
Hypnum fluitans Hedw., Sp. Musc. Frond., 296. 1801.
Drepanocladu fluitans var. *setiformi* (Ren.) Mönk.
Drepanocladus berggrenii (C. Jens.) G. Roth

Drepanocladus fluitans (Hedw.) Warnst.
Drepanocladus fluitans var. *uncatus* H.A. Crum, Steere & L.E. Anderson
Drepanocladus. fluitans var. *falcatus* (C.E.O. Jensen) G. Roth
Warnstorfia fluitans var. *falcata* (C.E.O. Jensen) H.A. Crum & L.E. Anderson

Var. **fluitans**

Not reported for Wyoming by FNA (FNA Vol. 28, 2014). (As *Hypnum fluitans* L.) Wyoming: Yellowstone Natl Park (*1574–75, 1581*) (Roell 1893); as fo. *depauperata* (sic): Yellowstone Natl Park (*1552*) (Roell 1893). (All as *Drepanocladus fluitans* (Hedw.) Warnst.) Snake River, Yellowstone Natl Park (*Nelson 6485*), Porter (1935). Yellowstone Natl Park, Porter (1937). Both of these are probably *Nelson 6485*, redetermined by me as *D. exannulatus*, q.v. Wynne (1944). Shoshone Natl Forest, NW Wyoming, Kosovich-Anderson (2010).



Courtesy FNA Association, FNA 28, 2014

Sheridan Co.: dominant species in sunnier areas, moist limestone, Big Horn Natl Forest, T57N, R89W, Section 34, *McKee 92–011*, with *Distichium capillaceum, Hylocomium splendens* (BUF, RM). Sublette Co.: Bridger Wilderness, Wind River Range, South Fork Baldy Creek headwaters, 10,290 ft, 42°59'N, 109°34'W, in small fen, with *Amblystegium riparium,* 16 May 1989,

Andrus 7827 (BING). Yellowstone Natl Park: in a woodland pool, Snake River, *Nelson & Nelson 6485,* exsiccat Plants of Yellowstone. Nat. Park, det. Holz. (RM).

There is a var. *falcata* (Sanio ex C. Jens.) Crum & Anderson in the Anderson et al. (1990) checklist but "Variety *falcata* (*Drepanocladus fluitans* var. *uncatus*) has been recognized, but because no type material seems to be extant, the status of this taxon cannot. be evaluated" (Hedenas, FNA Vol. 28, 2014).

Warnstorfia pseudostraminea (Müll. Hal.) Tuomikoski & T. Kop.., Ann. Bot. Fenn. 16: 223. 1979.
Hypnum pseudostramineum Müll. Hal., Bot. Zeitung (Berlin) 13: 502. 1855 (as pseudo-stramineum).
Calliergidium pseudostramineum (Müll. Hal.) Grout
Calliergidium pseudostramineum var. *hoveyi* Grout
Calliergidium pseudostramineum var. *plesistramineum* (Ren.) Grout
Drepanocladus pseudostramineus (Müll. Hal.) G. Roth

Wyoming (FNA Vol. 28, 2014).

WEISSIA Hedw., Sp. Musc. Frond., 64. 1801. (Pottiaceae)
Astomum Hampe
Hymenostomum R. Brown
Weissia sect. Astomum (Hampe) Müll. Hal.
Weissia subg. *Astomum* (Hampe) Kindb.
Weissia subg. *Hymenostomum* (R. Brown) Andrews

Weissia controversa Hedw., Sp. Musc. Frond., 67. 1801.
Gymnostomum rauanum Aust.
Mollia viridula (Withering) Lindb.
Weissia andrewsii E.B. Bartram
Weissia brandegeei Aust.
Weissia controversa var. *australis* (Austin) Schornherst
Weissia controversa var. *longiseta* (Lesq. & James) H.A. Crum, Steere & L.E. Anderson
Weissia controversa var. *wolffii* (Lesq. & James) H.A. Crum, Steere & L.E. Anderson
Weissia curvicaulis Brid.
Weissia longiseta Lesq. & James
Weissia microodonta Hedw.
Weissia viridula var. *nitida* Ren. & Card.
Weissia wolfii Lesq. & James

Not noted for Wyoming in FNA Vol. 27, 2007, but reported from stations in all encircling states.

(As *Weisia wolfii* L. & J.) Mammoth and Old Faithful, Yellowstone Natl Park (*Smiy*), Porter (1935). (As *Weisia convoluta*) Yellowstone Canyon, Yellowstone Natl Park (*Smiy*), *Porter, Smiy 46* (YELLO) has been determined to be *Dicranoweisia crispula* (q.v.), as is *93,* and *150* (YELLO).

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ADDITIONS TO THE NEW FLORA OF VERMONT

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ABSTRACT

Twenty-two species of vascular plants are reported for the state of Vermont, additional to those reported in the recently published New Flora of Vermont. These are *Agrimonia parviflora, Althaea officinalis, Aralia elata, Beckmannia syzigachne, Bidens polylepis, Botrychium spathulatum, Carex panicea, Carex rostrata, Eutrochium fistulosum, Ficaria verna, Hypopitys lanuginosa, Juncus conglomeratus, Juncus diffusissimus, Linum striatum, Lipandra polysperma, Matricaria chamomilla, Nabalus racemosus, Pachysandra terminalis, Parthenocissus tricuspidata, Ranunculus auricomus, Rosa arkansana*, and *Rudbeckia sullivantii.* Also new are three varieties: *Crataegus irrasa* var. *irrasa, Crataegus pruinosa* var. *parvula*, and *Viola sagittata* var. *sagittata.* Three species that have been reported elsewhere in 2013–2015, *Isoetes viridimontana, Naias canadensis*, and *Solidago brendiae*, are also recapitulated. This report and the recently published New Flora of Vermont (Gilman 2015) together summarize knowledge of the vascular flora of Vermont as of this date.

The New Flora of Vermont was recently published by The New York Botanical Garden Press (Gilman 2015). It is the first complete accounting of the vascular flora of Vermont since 1969 (Seymour 1969) and adds more than 200 taxa to the then-known flora of the state. However, the manuscript for the New Flora was finalized in spring 2013 and additional species are now known: those that have been observed more recently, that have been recently encountered (or re-discovered) in herbaria, or that were not included because they were under study at the time of finalization. In the same interval, other taxa have been reported elsewhere and data for those are recapitulated here based on the literature cited and specimens examined. Therefore, the catalogue of plants presented in the New Flora together with the taxa added below complete the entire list of vascular plants known in Vermont as of the date of this paper.

SPECIES AND VARIETIES NEW TO VERMONT

Entries are in the same general format as in the New Flora, including scientific name, place of publication, synonyms, and common name. Specimens are cited for each addition (new collections are deposited at VT) and species and discussions of taxonomy and other issues (e.g. invasiveness) are given where appropriate. For the benefit of users of keys in the New Flora, distinguishing characters are given.

ARALIACEAE

Aralia elata (Miq.) Seeman, J. Bot. 6: 134. 1968. Japanese angelica.

Vermont: **Chittenden County:** Burlington, disturbed forested fragment near Patchen Road on S edge of Centennial Woods Natural Area, 28 Oct 2013, *Testo 385* (VT). South Burlington, Allenwood Inn property, small tree to 3 m, 13 Jul 2014, *Mazowita s.n.* (VT).

Introduced from Japan. This species is considered potentially invasive (NPS 2012). It is well established near New York City (Moore et al. 2009) and known from New Hampshire, Massachusetts,

and Connecticut (Haines 2011). It differs from other *Aralia* in Vermont by shrubby habit with stout, erect woody stems, broad-based, stout prickles, and very large leaves. The inflorescence is a large, broad, showy, white panicle of numerous umbels.

ASTERACEAE

Bidens polylepis S.F. Blake, Proc. Biol. Soc. Wash. 35: 78. 1922. Ozark beggar-ticks.

> **Vermont**: **Franklin County:** Swanton, just E of Tabor Road (Missisquoi National Wildlife Refuge trails parking lot), unmowed damp pasture and along edges of Maquam Bog RR Trail, large patch, about 75 plants, 14 Sep 2013, *Gilman 13150* (VT, NEBC). **Chittenden County:** Colchester, near Winooski City line, under powerlines W side of Winooski Gorge, just S of RR tracks and E of I-89, 11 Sep 2014, *Gilman 14063 & Guerrero-Murphy* (VT, NEBC).

This species was first observed in Vermont at the Franklin County site in September 2013 by Eric Wood, a local wildflower enthusiast. The Vermont populations are disjunct from others in southern New England and New York. Given their habitat in disturbed areas, in one case along a hiking trail and in the other case in a utility corridor, they are likely to have been inadvertently introduced. Native to the American Midwest, other eastern populations of *Bidens polylepis* are considered to represent escapes or naturalized plants (Haines 2011; Voss & Reznicek 2012). This species differs from other *Bidens* in Vermont by its normally 3-compound leaves with narrowly lanceolate segments and large flowers (2–5 cm diameter). It is much showier than other Vermont *Bidens*.

Eutrochium fistulosum (Barratt) E.E. Lamont, Sida 21: 901. 2004. [*Eupatorium fistulosum* Barratt, *Eupatoriadelphus fistulosus* (Barratt) King & H.E. Robinson]. Hollow Joe-Pye weed.

> **Vermont: Rutland County:** Brandon, cleared area E of Hollow Road and W of old Brandon Training School, several large clumps, 3 Oct 2014, *Gilman 14084 & Guerrero-Murphy* (VT).

This species was excluded from the New Flora, no definite specimen having been seen. Jenkins and Zika (1995) discussed reports of this species (as *Eupatorium*) in Vermont and concluded that all were based on large plants of *E. maculatum* (L.) E.E. Lamont. The current, small population reported here is clearly *E. fistulosum* with stems hollow, more than 2 m tall and more than 2 cm diameter at base, and florets only 8–10 per capitulum. It may be that *E. fistulosum* was brought to the region with construction equipment (associated with recent construction in the cleared area) or perhaps, being wind-dispersed, it may be naturally adventive from its natural range, which includes New Hampshire, Massachusetts, and New York. It is also possible that, because the cultivar 'Gateway' is locally and recently popular in horticulture, this population may have originated as an escape.

Matricaria chamomilla L., Sp. Pl. 2: 891. 1753. Chamomile.

> **Vermont: Chittenden County:** Burlington, North Union Street, sidewalk, 26 June 2014, *Pet 15* (VT).

Introduced from Europe. Although reported from Vermont, e.g., in the Flora of North America (Brouillet 2006), no specimens have been encountered until now, although look-alike

Anthemis cotula L. is common and the similar *Tripleurospermum inodorum* (L.) Sch.-Bip., scentless mayweed, also occurs. It differs from the first in non-chaffy receptacle, from the second in its pleasant scent and non-winged achenes. It differs from Vermont's other species of *Matricaria*, *M. matricarioides*, in having showy, rayed capitula.

Nabalus racemosus (Michx.) Hook., Fl. Bor.-Amer. 1: 294. [*Prenanthes racemosa* Michx.]. Glaucous rattlesnake-root, glaucous white-lettuce.

> **Vermont: Windham County:** Wilmington, Haystack Mtn., steeply sloping, open, dominantly herbaceous ski run/lift line adjacent to a 2-track maintenance trail, 2150' [655 m], 17 Sep 2014, *Peters s.n.* (VT).

This species was excluded from the New Flora, no specimen having been seen. It was reported, as *Prenanthes racemosa*, from northwestern Vermont by Dole (1937), supposedly based on a specimen collected in Franklin County: Swanton by Blake, but was excluded by Jenkins and Zika (1995), who could not find a supporting specimen. Blake (1913), who collected other plants in Swanton in 1911, did not mention it and I also have not found a specimen to support Dole's report. Nor have I seen a supporting specimen for the statement by Bogler (2006, as *Prenanthes racemosa*) that it occurs in Vermont. Peters's label lists several "common, old-field" herbs present in the community.

Rudbeckia sullivantii C.E. Boynton & Beadle, Biltmore Bot. Stud. 1: 15. 1901. [*R. fulgida* Ait. var. *sullivantii* (C.E. Boynton & Beadle) Cronquist]. Sullivant's coneflower.

> **Vermont**: **Essex County**: Ferdinand, rough land between Vt. Rte. 105 and RR, W of Wenlock Crossing, small patch, 9 Aug 2014, *Gilman 14054 & Testo* (VT). **Caledonia County**: Danville, N side of US Rte. 2, just E of West Danville, small patch in wet, seepy, calcium-rich road scrape, 22 Sep 2013, *Gilman 13148* (VT, NEBC). Waterford: roadside, Duck Pond Road near Hale Road intersection, 31 Aug 2014, *Gilman 14056* (VT). **Washington County:** Berlin, under airport lighting system, near supermarket, SE corner of intersection of Paine Turnpike & Vt. Rte. 62, large patch, perhaps originating as a throw-away from cultivation but also spreading by seed over a small area, 21 Sep 2013, *Gilman 13144* (VT, NEBC).

This was treated as *R. fulgida* Aiton var. *sullivantii* by Urbatsch and Cox (2006) but Campbell and Seymour (2013) provided a rationale for treating it as a species. It is American, native to areas between the Appalachian Mountains and the Mississippi River. 'Goldsturm' is a popular cultivar in Vermont for landscaped public areas such as restaurant entrances, service station islands, medians, and public squares. Given its popularity and hardiness in the Vermont climate, it is not surprising that this species should become a casual escape.

BUXACEAE

Pachysandra terminalis Sieb. & Zucc., Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 4: 182. 1845. Japanese mountain-spurge.

> **Vermont: Bennington County**: Dorset, small patch along old Class IV town road, trail to quarries and Mt. Aeolus, about 100 ft from Dorset Hill Road and 200 ft from nearest residences, 1 Jun 2014, *Gilman 14004, Rosenthal & Testo* (VT).

Introduced from East Asia (China or Japan), *Pachysandra* is occasionally but not commonly used as a landscape plant in Vermont, being only marginally hardy as a wintergreen groundcover. The collection was from a small, spreading patch along an old trail through forest. It presumably originated as a throw-away. A more commonly used groundcover, common periwinkle (*Vinca minor* L.), was also abundant in the immediate area.

This addition represents a new family, Buxaceae Dumort., and a new order, Buxales Takht. ex Reveal, for Vermont. In the New Flora it would be placed between Proteales, Platanaceae, and Saxifragales, Paeoniaceae (APG 2009). Buxales is a small, poorly characterized order but like other near-basal clades within dicots, has instability in the number of floral parts. It is further characterized by racemose inflorescences, small flowers, and seeds with a multi-layered testa (Stevens, 2012).

CHENOPODIACEAE

Lipandra polysperma (L.) S. Fuentes, Uotila, & Borsch, Willdenowia 42: 14. 2012. [*Chenopodium polyspermum* L.]. Many-seeded goosefoot.

> **Vermont: Washington County:** Montpelier, one plant on gravel bar, Dog River, near playing fields/railroad junction, not far upstream of confluence with Winooski River, 21 Aug 2010, *Gilman 10118* (VT).

Adventive from Europe and Asia. This species was excluded from the New Flora, no definite specimen having been seen. Despite searching in the same area for several years, no additional plants were observed. The specimen was re-examined and determined as this species; it has rather blunt leaves and relatively lax inflorescences, representing the typical variety. *Lipandra polysperma* was treated as *Chenopodium polyspermum* by Clemants and Mosyakin (2004) but Fuentes-Bazan et al. (2012) demonstrated that it forms a monospecific genus. Among our chenopods, it differs in having non-farinose, entire leaves, elongate dichasial cymes, flowers spaced singly or in clusters of only 2–4, and non-keeled tepals that do not enclose the fruit. It also differs in having only 1(–3) stamen(s) vs. "almost always" 5 stamens in *Chenopodium s.s.* (Fuentes-Bazan et al. 2012).

CYPERACEAE

Carex panicea L., Sp. Pl. 2: 977. 1753. Grasslike sedge.

> **Vermont: Rutland County:** Mount Holly, North road embankment of Rte. 103, two rhizomatous colonies, 24 Jul 2014, *Peters s.n.* (VT).

This species has a primarily European distribution, although it is also likely indigenous in Greenland (Rothrock & Reznicek 2003). Here, on the embankment of a main paved road, it is likely adventive. In Vermont it is most similar to *C. livida* (Wahlenb.) Willd. from which it differs in being less glaucous, having slightly wider leaves, and having curved, not straight, perigynium beaks. Furthermore, its dry habitat is much different from the wetland habitat of *C. livida.*

Carex rostrata Stokes in With., Bot. Arr. Brit. Pl., ed. 2, 2: 1059. 1787. [Excl. var. *utriculata* (Boott) Bailey]. Beaked sedge.

> **Vermont: Windham County:** Newfane, wetland NE of Elwin Meadow in headwater of Baker Brook, 8 Aug 2012, *Engstrom s.n.* (VT).

This species was excluded from the New Flora, no definite specimen having been seen. Previous editions of the Flora of Vermont (Brainerd et al. 1900; Eggleston et al. 1915; Dole 1937; Seymour 1969) contained numerous reports of *Carex rostrata* but all previous specimens seen have been referred to *Carex utriculata* Boott, a taxon now regarded as a distinct species (Reznicek & Ford 2003). The two are distinguished by coloration (*C. rostrata* is very glaucous vs. green *C. utriculata*), leaf folding as seen in cross-section (U- or V-shaped in *C. rostrata*, W- or M-shaped in *C. utriculata*), and abundance of papillae on the epidermis of the leaves (many in *C. rostrata*, few in *C. utriculata*). They share similar habitats, although in New England *C. rostrata* is generally confined to northern Maine and New Hampshire in wetlands of boreal character (Haines et al. 2004).

Engstrom's field notes further elaborate the Windham County population: "Growing on floating organic mat piece in beaver-impounded fen dominated by *Carex lasiocarpa*, *C. stricta*, [and] *Calamagrostis canadensis*. Notable for its glaucous leaves. Rhizomatous. Other small pieces of floating mat with *Carex rostrata* around 2-meter tall beaver hut in midst of fen."

ERICACEAE

Hypopitys lanuginosa (Michx.) Raf., Med. Repos., ser. 3, 1: 297. 1810. [*H. lanuginosa* (Michx.) Nutt., later combination; *H. lanuginosa* var. *rosea* (Torr.) House, *Monotropa lanuginosa* var. *rosea* Torr.; *H., insignata* E.P. Bickn.; *Monotropa hypopitys* var. *rubra* Farw.; *M. hypopitys* f. *rubra* (Farw.) Seymour]. Reddish pine-sap.

> **Vermont: Chittenden County:** (South Burlington), woods between Spear and Dorset streets, 3 Sep 1902, *Ross s.n.* (VT). **Addison County:** Leicester, Chandler Ridge, 4 Sep 2014, *Burns* (VT, photo!). **Windham County:** Newfane, 15 Sep 1897, *Howe* (VT).

Seymour (1969) provided a key (i.e. based on flower color) that included this reddish variation but did not specifically mention a location or collector, so its presence in Vermont was not addressed in the New Flora. Variation within indigenous pine-sap has long been a source of taxonomic ambiguity in the North American literature. This taxon, differing from *Hypopitys monotropa* Crantz in color (pink to red vs. yellowish) and in flowering period (aautumn vs. mid-summer) has been treated as merely synonymous with that by most recent authors including Fernald (1950), Gleason & Cronquist (1991), Wallace (2009) and Haining and Wallace (2005). However, Haines (2011) recognized it as a species, based on increasing evidence (Klooster & Culley 2010) that it is distinct, even when growing in sympatry with *H. monotropa*. Klooster and Culley (2010) suggested that it might best be considered a subspecies, but no combination at any subspecific rank in *Hypopitys* is available (subspecific combinations are available if the species is maintained in *Monotropa*). Typification of the epithet *lanuginosa* for the red-flowered taxon may be problematic because, in his protologue Michaux (1803) focused on plant pubescence, not on the critical characters of color and phenology. However, a specimen in the Michaux Herbarium at P (IDC fiche 61-5) is labeled "*fleurs rubantes*" (W. Taylor, pers. comm.) and it appears the red-flowered plant was within Michaux's concept of *lanuginosa*. The Vermont collections suggest that *H. lanuginosa* is associated with oak-beech forests in the lower elevations, while *H. monotropa* may be found in mixed or coniferous forests throughout the state. The older collections cited, from Chittenden and Windham counties, were annotated based on their late flowering dates and very pubescent stigma bases (Britton & Brown 1913; Haines 2011). Their color could not be assessed.

JUNCACEAE

Juncus conglomeratus L., Sp. Pl. 1: 326. 1753. Bunch-flowered soft rush.

> **Vermont: Windham County:** Wilmington, near Vt. Rte. 9, wet field, old agricultural land with iron seeps, 8 Aug 2014, *Greene-Swift s.n.* (VT).

This rush is considered to be introduced from Europe to North America (Hämet-Ahti 1980). It has been variously considered a species or a variety of common soft rush (*Juncus effusus* L.) but recent research shows it to be well differentiated from that species (Michalski & Durka 2015). In Vermont it might be confused with *J. effusus* var. *solutus* Fern. & Wieg., some forms of which have relatively compact inflorescences, but it differs in having many fewer ridges of the culm (12–30 vs. 30–60) and a relatively longer sheathing basal leaf (uppermost of several). *Juncus pylaei* Laharpe is also similar but is often a larger plant with a more open inflorescence and its inflorescence bract is tight vs. somewhat inflated at the base in *J. conglomeratus*.

Juncus diffusissimus Buckley, Proc. Acad. Nat. Sci. Philadelphia 14: 9. 1862. Slim-fruited rush.

> **Vermont**: **Chittenden County:** Essex, former earth extraction area known as the "Bushey Sand Pit," N of Vt. Rte. 117 (opposite N Williston Road), commonly scattered over a wide area, 5 Nov 2013, *Gilman 13159* (VT, NEBC).

Juncus diffusissimus is unlikely to be confused with any other rush. A member of subgenus *Septati* Buch., which is characterized by septate-nodulose leaves, its distinguishing characters are its caespitose habit, large open inflorescences with widely divergent branches, capitula with typically 3–10 flowers, and narrow, slender, elongate capsules, as much as two times as long as the perianth. It is known to be undergoing significant range expansion to the north and east of its natural range (Lamont & Young 2005; Haines 2011). Lamont and Young (2005) indicated that habitats in the range expansion area are often heavily disturbed by heavy machinery and are typically on sandy soils, especially if seasonally damp. It seems likely that it entered this site — an earth extraction area — as seeds on earthmoving equipment or in soil from another state.

LINACEAE

Linum striatum Walt., Fl. Carol., 118. 1788. Ridged yellow flax.

> **Vermont: Windham County:** Dummerston, few in wet access road in a cleared area, N side of the West River, 3 Oct 2014, *Gilman 04083 & Guerrero-Murphy* (VT).

Indigenous species of *Linum* are poorly represented in Vermont, with only *L. medium* (Planch.) Britton and *L. sulcatum* Riddell previously known, and those are from very few collections (Gilman 2015). *Linum striatum* is known from Massachusetts and southward and appears to be adventive to this site. It is a species of wet habitats vs. the somewhat similar *L. virginianum* L. (not in Vermont), which favors dry habitats. Morphologically, it differs in having ridged stems (the ridges decurrent from leaf bases) and eciliate septa of the fruit (i.e., the margins of the fruit segments lack hairs).

MALVACEAE

Althaea officinalis L., Sp. Pl. 2: 686. 1753. Marshmallow.

> **Vermont: Washington County:** Plainfield, Great Brook Road near Maxfield Road, in area with houses but no cultivated plants nearby; seems to be an escape or unintentional introduction, one large plant, 27 Jul 2012, *Gilman 12079* (VT, NEBC). **Addison County:** Addison, N end of Mountain Road near Vt. Rte. 17, below Snake Mountain, 10–15 plants scattered and appearing naturalized, dirty with road-dust, 10 Aug 2013, *Gilman 13099 & Greene-Swift* (VT, NEBC).

Introduced from Europe. These populations probably represent localized escapes from horticulture. No other species of *Althaea* occur in Vermont and these plants are unlikely to be confused with any other local genus of Malvaceae. Especially distinctive is its pale grayish-green aspect due to the heavy indumentum of woolly hairs. Although widely known for its culinary and herbal uses, i.e. as marshmallow, such use is not traditional in Vermont. Hill (2015) noted that there are not many recent records for this species in North America.

OPHIOGLOSSACEAE

Botrychium spathulatum W.H. Wagner, Amer. Fern J. 80: 77. 1990. Spatulate moonwort.

> **Vermont: Bennington County:** Dorset, Mt. Aeolus, light woodland on old disturbed site, near quarry, 1 Jun 2015, *Rosenthal s.n.*. (IA; photo VT).

This is the third species of recently described moonwort to be discovered in Vermont, all at the same macrosite; others are *Botrychium ascendens* W.H. Wagner and *B. campestre* W.H. Wagner & Farrar (Gilman 2015). The specimen cited here was sent to Don Farrar, Iowa State University, who identified it based on allozyme analysis. The populations of all three at this site are quite small.

This species differs from other moonworts in Vermont in several characters. From the co-occurring *Botrychium ascendens* and *B. campestre*, it differs conspicuously in having pinnae that are spatulate to broadly fan-shaped with nearly entire, rounded distal margins (vs. nearly linear to narrowly fan-shaped with crenate to dentate distal margins). Across its range, *B. spathulatum* may have pinna margins with shallowly incised, rounded lobes, while those observed locally have, at most, very shallowly crenate pinna margins. *Botrychium spathulatum* may also be confused with *B. minganense* Vict. but it has sessile vs. stalked trophophores and the basal pinnae are larger than the next most basal pair (smaller in *B. minganense*). It is an allotetraploid related to *B. campestre* (Hauk et al. 2012).

PAPAVERACEAE

Macleaya cordata R. Br., Narr. Travels Africa, app. 218. 1826. Plume poppy.

> **Vermont: Rutland County:** Proctor, vacant field, 16 Sep 1924, *Kittredge s.n.* (VT).

Introduced from East Asia (China or Japan), this species was excluded from the New Flora, the specimen cited above being overlooked during development of the New Flora. It was mentioned by Dole (1937) but also overlooked, or not found, by Seymour (1969). Plume poppy is occasionally cultivated in Vermont and the specimen appears to represent a casual escape. This monotypic genus is much different from other Papaveraceae in Vermont, plume poppy being a tall, robust perennial with small, non-showy, wind-pollinated flowers.

POACEAE Tribe **Poeae**

Beckmannia syzigachne (Steud.) Fern., Rhodora 30: 27. 1928. Sloughgrass.

> **Vermont: Addison County:** Shoreham, wet depression in hayfield, low terrain near Lemon Fair River, 18 Jul 2014, *Gilman 14027* (VT).

A tall annual grass of wet habitats, *Beckmannia syzigachne* is native in North America. It is very distinctive in appearance. Its inflorescences are erect panicles with short, ascending racemose branches. Spikelets are densely arrayed on the racemes and individually are very compressed. The glumes are enlarged, and spongy-inflated. They are each D-shaped and face each other, giving the individual spikelet a nearly round, winged appearance. The lemma and palea are enclosed by the glumes, although their tips protrude. *Beckmannia* is most closely related to *Alopecurus* L. (Xu et al. 2009) but, given these characters, it is unlikely to be confused with that genus or any other grass in Vermont. It is likely adventive from farther west. The habitat of the current population, an unmowed wet, muddy swale in a hayfield, is similar to that described elsewhere in North America. Introduction by waterfowl is a likely explanation for its presence.

RANUNCULACEAE

Ficaria verna Huds., Fl. Angl., 214. 1762. [*Ranunculus ficaria* L.]. Lesser celandine, fig crowfoot.

> **Vermont: Chittenden County:** Salmon Hole Park, S side of Winooski River, disturbed open woods in sandy soil and along open bank, 29 Apr 2014, *Testo 406* (VT, 2 sheets).

Introduced from Europe. The population from which the specimen cited was collected was first detected ca. 2006 by Leif Richardson (pers. comm.) but no specimen was collected at that time. In 2014, it was abundant at this location (W.L. Testo, pers. comm.). This species was treated as *Ranunculus ficaria* in the Flora of North America by Whittemore (1997) but Emadzade et al. (2010) concluded that *Ficaria* is best treated as a segregate genus. It differs from *Ranunculus* in several "distinct features: three sepals, more than five petals, and stalked but non-beaked achenes" (Emadzade et al. 2010). Haines (2011) indicated that some New England collections belong to subsp. *bulbifera* Á. & D. Löve; no bulbils are present on the above-cited specimens, collected at anthesis.

Ranunculus auricomus L., Sp. Pl. 1: 551. 1753. Goldilocks buttercup.

> **Vermont: Essex County:** Concord [mislabeled as Caledonia County: Kirby], Hutchinson Farm, 27 May 1920, *Hutchinson s.n.* (SJFM); Concord Twp., West Concord, near junction of US Rte. 2 and Kirby Hill Road, roadside ditches and abundant in fields, covering 1000's of square feet, 24 May 2015, *Gilman 15006* (VT, NEBC).

Apparently adventive from Europe. This aggregate species has been reported in North America only from East Greenland (Whittemore 1997) and Alaska (Elven 2015), although the latter plants are referred to a segregate (micro)species, *R. ponojensis* (Markl.) Ericsson (Elven 2015).

Ranunculus auricomus sensu lato occurs throughout much of Eurasia and is not confined to arctic or subarctic regions. It exhibits both sexual and apomictic elements and is characterized by an abundance of microspecies. Hörandl et al. (2009) investigated several clades in the group and came to the conclusion that only the sexual elements should be named as species because the microspecies, even those with invariant morphology, may each have numerous origins. Plants found in Vermont may be apomictic, as they have some apetalous flowers with poorly formed pollen. They have no

scales (cataphylls), rather deeply 3-divided basal leaves, cauline leaves with entire or nearly entire, linear lobes, glabrous leaves and stems, and pubescent achenes. In the treatment of Tutin and Akeroyd (1993), they key directly to *R. auricomus*, and they comport with the probable type, Sheet 715.21 of the Linnean Herbarium (2016). *Ranunculus auricomus* is readily distinguished from other non-native buttercups of open fields in Vermont. From *R. acris* L. it differs by its smaller size, more deeply divided basal leaves, cauline leaves with linear, entire or nearly entire segments, and less compressed, pubescent achenes. It differs from *R. bulbosus* L. in these characters, its lack of a swollen stem base, and in sepals not reflexed at anthesis.

In 1920, local botanist Inez A. Howe of the Fairbanks Museum (SJFM) in St. Johnsbury reported *Ranunculus boreanus* Jord. from Vermont (Howe 1920). She had received a specimen in 1917 from a correspondent, Miss Edith Hutchinson, who indicated that it grew "plentifully on her father's farm," which was in West Concord (Childs 1887), i.e. the same general area as the current collection of *R. auricomus*. Howe identified it by reference to a recently published report of *R. boreanus* in New York (Phelps 1919) that emphasized that species's early flowering date and its finely dissected leaves — also characters of *R. auricomus*. (Later in 1920, the specimen cited here was collected and deposited at SJFM.). *Ranunculus boreanus* is now synonymized with *R. acris* L. (Coles 1971). Following the discovery of *R. auricomus* in 2015, I inspected the SJFM specimen of "*R. boreanus*" and confirmed its identity as *R. auricomus*. It now seems likely that *R. auricomus* has been in Vermont for nearly a century. Its manner of introduction is unknown, but was likely to have been related to agriculture.

ROSACEAE

Agrimonia parviflora Aiton, Hort. Kew. 2: 130. 1789. Small-flowered agrimony.

> **Vermont: Rutland County:** Clarendon, east side of Vt. Rte. 7B, N of airport, at edge of wetland in old field. 15 Jul 2015 (foliage) & 15 Sep 2015 (fruit), *Greene-Swift s.n.* (VT).

Known from New York, Massachusetts, and points south and west (Kline & Sørenson 2015), this species differs from other agrimonies occurring in Vermont in having more numerous leaflets (ca. 5–8 pairs vs. 2–4 pairs). Given its position here in a man-altered landscape, albeit an abandoned field not in current use, and the species' obvious dispersal capabilities via its "stick-tight" or "beggar's-tick" fruits, it is likely that this small colony represents a recent introduction.

Crataegus irrasa Sarg., Rhodora 5: 116. 1903. var. ***irrasa.*** Zigzag hawthorn.

> **Vermont**: **Caledonia County:** Newark, W side of Vt. Rte. 114, 1.0 mi S of Hawk Rock Road, just S of a small tributary to the East Branch of the Passumpsic River, large patch, 21 May, 15 Jun, 27 Jul, and 25 Aug 2013, *Gilman 13023* (VT, NEBC).

This taxon was reported from Vermont by Seymour (1969) but all specimens cited by him are referred to *C. oakesiana* Eggl., which is recognized as a separate species in the New Flora (Gilman 2015). That species is a near endemic, described (Eggleston 1907) from Bloomfield, Essex County, Vermont, and distributed in a few towns along the upper Connecticut River in Vermont and New Hampshire. These areas are approximately 20–40 km distant from the current population of *C. irrasa* var. *irrasa*.

Crataegus irrasa var. *irrasa* is, indeed, much like *C. oakesiana* (Fig.1a). Both have a thicket-forming habit, pubescent inflorescences, flowers with 20 stamens, and pale yellow anthers. Seymour's disposition, therefore, is understandable. Nevertheless, the two differ significantly in leaf shape, those of *C. irrasa* being more broadly truncate (to even slightly cordate) and having broader, larger lobes (Fig. 1b). The leaf bases of mature foliage sometimes cannot be pressed without folding due to their subcordate shape. Notably, Seymour (1969) illustrated leaves of most Vermont hawthorn taxa (in many instances with photos of type material) but did not include an illustration of either *C. irrasa* var. *irrasa* or of *C. oakesiana*. *Crataegus irrasa* is also represented in Vermont by the pink-anthered var. *blanchardii* (Sarg.) Eggl., a taxon recently transferred to *C. chrysocarpa* (Phipps

a. *C. oakesiana* b. *C. irrasa* var. *irrasa* c. *C. chrysocarpa*

Fig. 1: Local representatives of *Crataegus* Ser. *Rotundifoliae* showing leaf shapes at anthesis. Note the broadly cuneate floreal leaves of *C. oakesiana* (a) and *C. chrysocarpa* (c); those of *C. irrasa* (b) are broadly truncate to nearly cordate.

2007). That variety is known from the Green Mountains of southern and north-central Vermont, but not from the northeastern part of the state. The species was described from Île de Montréal, Québec (Sargent 1903), about 180 km distant, and is otherwise known from Québec, Michigan, and New York (Palmer 1952). Phipps (2015) noted that it was "to be expected in New England." The current population of *C. irrasa* var. *irrasa* is from a roadside thicket and may have been casually introduced.

Another taxon on Series *Rotundifoliae* Rehder that is characterized by twenty pale yellow anthers is *Crataegus chrysocarpa* Ashe var. *vigintistamina* J.B. Phipps, but *C. chrysocarpa* has "rather differently formed leaves" (Phipps 2007; and see Fig. 1c above). Variety *vigintistamina* is not known to occur in the state.

Crataegus pruinosa (Wendl. f.) K. Koch var. ***parvula*** (Sarg.) J.B. Phipps, Canad. J. Bot. 58: 1684. 1980. Small-leaved frosted hawthorn.

Vermont: Rutland County: West Rutland, 15 Sep 1899, *Eggleston & Brainerd* (GH).

The recent publication of the Flora of North America revision of hawthorns (Phipps 2015) reveals a few discrepancies with the treatment in the New Flora, which was based on that of Haines in Flora Novae-Angliae (2011). They will not be recapitulated here except to note this small-leaved variety of *Crataegus pruinosa*, which was placed in synonymy of the typical variety by Haines (2011) but recognized by Phipps (2015). It has nowhere been reported from Vermont, including the Flora of North America (Phipps 2015) and was not included in synonymy of *C. pruinosa* in the New Flora. Nevertheless, the above-noted specimen, annotated by Phipps, has been seen. Haines (pers. comm.) finds that there are other named varieties connecting taxon *parvula* directly to the typical variety, and considers it not sufficiently distinct to warrant recognition.

Rosa arkansana Porter, Syn. Fl. Colorado 38. 1874. [*R. arkansana* var. *suffulta* (Greene) Cockerell]. Prairie rose.

> **Vermont**: **Essex County:** Brighton, large clone, field margin, S side of Vt. Rte. 105, just W of Boylan State Airport, 5 Jul 2014, *Gilman 14025* (VT, MO). Ferdinand, N side of Vt. Rte. 105 just W of Wenlock, edge of maintained roadway, small patch (10–15 stems) (note that woody stems have been mowed in a portion of the group), 17 Aug 2013, *Gilman 13109* (VT, NEBC, MO).

Rosa arkansana was casually mentioned for Vermont in the Flora of North America by Lewis et al. (2014), based on the cited Ferdinand specimens, but it was not mapped nor was Vermont among the states listed in the statement of range. It is native to the central part of the continent (Erlanson 1929) and occurrences farther east are likely to have been introduced (Voss & Reznicek 2012; Lewis et al. 2012). In northern New England, it is also known from man-altered habitats such as old fields and along railroads in Maine and New Hampshire (specimens at NEBC!). Its discovery in northeastern Vermont along a two-lane highway — and not far from a railroad — is consistent with this pattern.

This species is much like *Rosa blanda* Ait., differing in leaflets normally (7–)9(–11) vs. (5–)7(–9), in stems prickly along their entire lengths, including current year's growth vs. prickly only on older stems, and in inflorescences terminating erect new shoots vs. on spreading lateral shoots. The Vermont plants are moderately pubescent and represent the eastern phase of the species sometimes segregated as var. *suffulta*. Lewis et al. (2012), however, did not recognize that variety.

VIOLACEAE

Viola sagittata Aiton, Hort. Kew 3: 287. 1789. var. ***sagittata***. Arrow-leaved violet.

> **Vermont: Orleans County:** Town line of Greensboro-Glover, 24 Aug 1968, *Gates & Urie* (VT).

The typical variety of arrow-leaved violet was excluded from the New Flora because the specimen cited here was overlooked during its development. It represents the expression of the species with elongate leaf blades that are prominently and narrowly lobed at base, while var. *ovata* (Nutt.) Torr. & A. Gray, which is frequent in Vermont has more ovate, unlobed or only poorly lobed leaves. The specimen cited bears one fruit elevated on a peduncle approximately half the height of the entire specimen. The location in northern Vermont is somewhat remote from other known populations in New England.

Viola sagittata var. *sagittata* was mapped for Vermont by Russell (1965) based on specimens, collected by others (VT!) that he had personally annotated as "nearer" var. *sagittata* than var. *ovata*.

In the New Flora, I regarded those specimens as too equivocal to support Russell's report. The report by Seymour (1969) from Windsor County: Barnard, was based on his own collection, *Seymour 23,560* (VT!), which is a specimen of var. *ovata*. McKinney (1992) did not map var. *sagittata* from Vermont and cited no Vermont specimens, and Little and McKinney (2015) excluded it as well.

VITACEAE

Parthenocissus tricuspidata (Siebold & Zucc.) Planch., Monogr. Phan. 5: 452. 1887. Boston ivy.

> **Vermont**: **Chittenden County:** Burlington, apparently spontaneous on cement block wall facing Lake Champlain, Burlington Bikepath, near the Old Barge Canal; no apparent landscape plantings in area, 4 Jul 2008, *Gilman 08043* (VT).

Introduced from East Asia (China or Japan), this species was inadvertently not included in the New Flora. Boston ivy is marginally hardy in Vermont and is seldom used as building-climbing plant. Even so, the specimen probably represents a local escape from cultivation: although it was growing on hardscape, it was not in an area of softscape plantings. Boston ivy is readily distinguished from other Vermont *Parthenocissus* by entire vs. pentafoliolate leaves and from *Vitis* (which has similar leaves) by non-shreddy bark and tendrils with adhesive disks.

ADDITIONS FIRST REPORTED ELSEWHERE

Three species have been newly reported by others for Vermont since 2013 and are briefly recapitulated here. Additionally, Phipps (2015) newly reported *Crataegus chrysocarpa* Ashe var. *subrotundifolia* (Sargent) J.B. Phipps from Vermont, but the basis of that record has not been ascertained. There are no specimens so named at VT, A, GH, or NEBC.

ASTERACEAE

Solidago brendiae Semple, Phytoneuron 2013-57: 1–4, figs. 1–2. 2013. Brenda's goldenrod.

> **Vermont: Essex County:** Granby, 30 Sep 1972, *B.H. Stearns* (VT).

Semple (2013) recently described this species of eastern Canada. It is much like *Solidago canadensis* L. but has more prominently bracteate, minutely glandular inflorescences, slightly larger capitula, and more ray florets. The specimen cited was discovered upon review of goldenrod specimens at VT by Gilman, specifically searching for records of *S. brendiae* in Vermont, and was confirmed as such by Semple (Semple & Gilman 2015). Essex County is at the southern edge of the boreal zone favored by *S. brendiae*.

HYDROCHARITACEAE

Najas canadensis Michx., Fl. Bor.-Amer. 2: 220. 1803. Canada naiad.

> **Vermont: Franklin County:** Swanton, Missisquoi National Wildlife Refuge, 24 Aug 1962, *Moses s.n.* (VT). **Grand Isle County:** North Hero, 8 Aug 1878, *Flynn s.n.* (VT). **Chittenden County:** Back Bay, Aug 1908, *Jones s.n.* (VT). **Orange County:** Brookfield, Baker Pond, 29 Aug 1972, *Seymour 30,075* (VT). **Washington County:** Calais, Bliss Pond, 13 Sep 1968, *Seymour 27,140 p.p. & Dudey* (VT). **Windham County:** Ct. River N of Bellows Falls, 14 Aug 1986, *Hill 17053* (VT).

Les et al. (2014) distinguished this taxon, which is a tetraploid derived from crosses between *N. flexilis* (Willd.) Rostk. & W.L.E. Schmidt and *Najas guadalupensis* (Spreng.) Magnus, as a "cryptic, sympatric species." It occurs with *N. flexilis* across much of the latter's range in North America and has been confused with that species in the past. Canada naiad can be distinguished from *N. flexilis* by its "thick," plumply fusiform seeds (< 3.0× as long as wide) vs. "thin," narrowly fusiform seeds (>3.0× as long as wide). Les et al. (2014, fig. 1) mapped a population from western Vermont, and review of specimens as listed above confirm that it is widespread in the state. *Najas flexilis*, also mapped by Les et al. (2014), is also widespread in Vermont.

ISOETACEAE

Isoetes viridimontana M. Rosenthal & W.C. Taylor, Amer. Fern J. 104: 7. 2014. Green Mountain quillwort.

> **Vermont: Windham County:** Wilmington, Haystack Pond, 20 Aug 2013, *Taylor 6743 et al.* (holotype US, isotype VT).

This newly described species (Rosenthal et al. 2014) is known from only one site. It differs from other quillworts by its small size (maximum number of leaves 17 and maximum number of megaspores 40), granulate to rugulate megaspores ca. 0.36 mm in diameter, and echinate microspores. It is diploid (2n =22) and is most closely related to *Isoetes engelmannii* A. Braun (Rosenthal et al. 2014). Because of its rarity, it is of conservation concern and has been added to Vermont's statutory list of threatened and endangered, legally protected species.

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A NEW VARIETY OF *ABRONIA MELLIFERA* (NYCTAGINACEAE) OF CONSERVATION CONCERN IN SOUTHWESTERN IDAHO

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ABSTRACT

Abronia mellifera var. **pahoveorum** Ertter & Nosratinia, **var. nov.**, is described from hills on the north side of the Snake River Plains in southwestern Idaho. Because of the immediate need for conservation attention, this variety is published in advance of a more detailed revision of the *A. mellifera* clade. It differs from other members of the clade in the larger inflorescence bracts that are often broadly ovate or even orbicular, and in the combination of lack of rhizomes, relatively narrow, green, flexible leaves, glandular-septate trichomes in the inflorescence, and moderately hairy fruit with relatively large wings.

A combined morphological, ecogeographical, and molecular analysis of *Abronia mellifera* Douglas ex Hook. supports the recognition of several new taxa within this clade. Although the full analysis and revision is still in preparation, one variety is sufficiently vulnerable to merit expedited publication so that conservation efforts can proceed unimpeded. Varietal rank is selected because of transitional populations in the western part of the range. The new variety includes plants previously identified as *A. fragrans* Nutt. ex Hook. using Hitchcock and Cronquist (1973), which as currently circumscribed does not exist in the Pacific Northwest (Galloway 2003). Further details will be provided in the aforementioned revision. Only characters diagnostic within the clade are provided in the varietal description; other characters are as given for *A. mellifera* sensu lato in recent floristic treatments (Galloway 2003; Spellenberg 2012).

Abronia mellifera Douglas ex Hook. var. **pahoveorum** Ertter & Nosratinia, **var. nov.** **TYPE: USA. Idaho.** Ada Co.: Above Stack Rock Drive in foothills NE of Shadow Valley Golf Course NW of Boise, old road cut on S-facing slope with dark sand and layers of basalt, 43.7483° N 116.28145° W, 914 m, 19 May 2015, *B. Ertter 22323* with P. Shaffer (holotype: UC; isotypes: ID, MO, NY, OSC, RM, SRP, WTU).

Differs from other elements of the *Abronia mellifera* clade in the larger inflorescence bracts that are most often broadly ovate or even orbicular (Fig. 1), and in the combination of lack of rhizomes, relatively narrow, green, flexible leaves (Fig. 2), glandular-septate trichomes in the inflorescence, and moderately hairy fruit with the top margin of the largest wing 3–5 mm.

Figure 1. Comparison of extreme form of involucral bracts of *Abronia mellifera* var. *pahoveorum* (left) to bracts otherwise characteristic of the species (right; representative of populations in Owyhee County, Idaho). All photos by first author.

Figure 2. Comparison of proximal leaf shape and color of *Abronia mellifera* var. *pahoveorum* (top) to leaf from an as yet unnamed variety in Owyhee County, Idaho (bottom; similar to typical variety).

Well-developed plants forming mounds to 10+ dm diam. (Fig. 3); slender rhizomes absent. **Stems** decumbent to more often ascending, (5–)14–55 cm. **Leaves:** petiole (1–)1.5–5 cm, distal ones shorter than leaf blade; leaf blade usually green, flexible, proximal ones (1–)2–6(–8.5) cm long, (0.5–)0.8–2(–2.5) cm wide, narrowly to broadly elliptic-lanceolate, the base cuneate to obtuse. **Inflorescences:** peduncle (6–)10–28 cm, usually ascending in fruit, rarely perpendicular to stem, vestiture of abundant to dense stipitate and septate glands (sometimes sparser and shorter or even subglabrous in west part of range); heads 5–7 cm diam.; bracts 10–15(–20) mm long, (4–)8–12(–17) mm wide, usually broadly ovate to nearly orbicular, sometimes narrowly ovate in older plants, usually strongly overlapping; flowers 26–34 per inflorescence, mildly fragrant; tube 15–22 mm long, green to pinkish; throat 1.5–3 mm diam.; limb 10–15 mm diam.; style situated well below anthers. **Fruits:** outermost wingless or with irregular rudimentary wings, others with well-developed wings; vestiture of winged fruit ± glandular-pubescent, not restricted to fruit apex and upper wing margins; lateral margin of largest wings (5–)7–10(–12) mm, top margin of largest wings 3–5 mm, wing angle (as per Spellenberg 2012) 105–150°; fruit beak 1–3 mm; achene 3.5–4 mm. **Flowering** April to September. **Elevation** 730–1100 m.

Figure 3. Well-developed plant of *Abronia mellifera* var. *pahoveorum* at type locality, in full bloom on overcast morning.

The new variety is named to honor all the dedicated members of the Pahove Chapter of the Idaho Native Plant Society, many of whom have contributed directly to past and current understanding of this new variety, and whose collective efforts will be instrumental in ensuring the continued existence of this beautiful plant. "Pahove sand-verbena" and "Boise sand-verbena" are both appropriate vernacular names.

Variety *pahoveorum* is restricted to a relatively narrow band of sand hills and lake bed sediments below 1100 meters on the north side of the western Snake River Plains in southwestern Idaho. The easternmost historical location is near Lucky Peak Dam east of Boise; sporadic populations occur (or occurred) northwest from here along the Boise Front to Horseshoe Bend, and west in the sandy ridge separating the Boise and Payette rivers.

It is not often that a new plant is described within walking distance of an author's house, especially when that house is in one of the original neighborhoods of a capitol city in the USA. The unfortunate consequence is that var. *pahoveorum* is by far the component of the *Abronia mellifera* clade most urgently in need of conservation attention. Its range overlaps prime real estate for housing development, and what hasn't been developed is subject to severe habitat alteration by *Bromus tectorum, Secale cereale,* and other invasive non-native species. Less than 100 plants were located in 2015, with one of the larger populations (used for the type) on a site subsequently purchased with plans for development. No plants could be found at three historical localities, and only ten plants total were found at three other locations. Several hundred fruit were collected from the site scheduled for development; these have been shared with the Idaho Botanical Garden and other propagators.

Additional representative specimens. **Idaho. Ada Co**.: Lucky Peak, T2N R3E S12, 13 Jun 1983, *Steele 1512* (BOIS); Bogus Basin Road ca 5.5 mi from Hill Rd., 31 May 2009, *Ertter & Hosford 19409* (to be distributed to CIC, NY, UC, WTU); Spring Valley Ranch, 18 May 1949, *Lingenfelter 664* (SRP). **Boise Co.**: ca 3 mi SW of Horseshoe Bend, 20 Jul 1939, *Beard 11878* (ID, NY). **Canyon Co.**: Caldwell, May 1902, *Marlatt s.n.* (CIC). **Gem Co.**: Emmett, 9 Jun 1911, *Macbride 882* (NY, WS); along Payette River E of Montour Bridge, May 1980, *Manwaring s.n.* (IDS). **Payette Co.**: Big Willow ["Canyon Co."], 1 Jun 1910, *Macbride 175* (NY, UC, WTU); ½ mi S of Langley Gulch Power Plant, 6 Aug 2015, *Ertter et al. 22430* (to be distributed to CIC, UC, WTU). Specimens from near Vale in Malheur Co., Oregon, are intermediate between var. *pahoveorum* and an as yet unnamed variety in Owyhee Co., Idaho; their optimum placement has not yet been decided.

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TYPIFICATIONS OF *LINANTHUS PARVIFLORUS* VAR. *CROCEUS* MILLIKEN AND *LINANTHUS CROCEUS* EASTW. (POLEMONIACEAE)

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ABSTRACT

Type collections of *Linanthus parviflorus* var. *croceus* Milliken and *Linanthus croceus* Eastw. have been interpreted as coming from a single gathering by Alice Eastwood. We postulate two Eastwood gatherings are involved: the first dated 9 May 1901, and the second dated 19 May 1901. So far as we know, a single specimen from the 9 May gathering exists; it is in CAS; we consider it to be the holotype of *Linanthus croceus* Eastw. So far as we know, no specimen of the 19 May gathering that was originally in CAS is in CAS now; duplicates of the 19 May gathering constitute a pool of specimens from which we designate a lectotype of *Linanthus parviflorus* var. *croceus* Milliken. **Leptosiphon croceus** (Eastw.) Strother & Kersh, **comb. nov.**, fills a void that resulted from "Leptosiphon croceus (Eastw.) J.M. Porter & L.A. Johnson" having not been validly published.

In protologue for *Linanthus parviflorus* (Benth.) Greene var. *croceus* Milliken, Univ. Calif. Publ. Bot. 2:59. 10 May 1904, Milliken wrote, "Local, limited to about ten acres near the stage road from Colma to Blenheim, San Mateo Co., Alice Eastwood, May 19, 1901. It is labeled by Miss Eastwood in the California Academy of Sciences as a var. of *Gilia androsacea*." Because Milliken cited a single specimen, that specimen must be considered the holotype of *L. parviflorus* var. *croceus* Milliken. At present, we know of only one specimen in CAS that accords with the Milliken protologue; it came to CAS from DS after 1960 (details of that specimen below).

We presume the holotype, cited as "... in the California Academy ..." by Milliken, has been lost, probably in the 1906 fire that destroyed nearly all botanical specimens that were housed in CAS at that time. Specimens that do accord with protologue of *L. parviflorus* var. *croceus* Milliken are known, namely:

DS133196 (now in CAS, barcode 226727) - California Academy of Sciences/ Herbarium Part of Type Coll./ Linanthus croceus Eastwood/ Blenheim, San Mateo Co., Cal./ Coll. Alice Eastwood, 19 May 1901.

GH00078828 - California Academy of Sciences/ Herbarium Part of Type Coll./ Linanthus croceus Eastwood/ Blenheim, San Mateo Co., Cal./ Coll. Alice Eastwood, 19 May 1901.

NY00336940 - California Academy of Sciences/ Herbarium Part of Type Coll./ Linanthus croceus Eastwood/ Blenheim, San Mateo Co., Cal./ Coll. Alice Eastwood, 19 May 1901.

POM3565 (from C.F. Baker Herbarium, now in RSA, barcode 0004836) - PLANTS OF CALIFORNIA/ Linanthus croceus Eastwood/ Blenheim, San Mateo Co./ Collected by Alice Eastwood, 19 May 1901/ Part of Type collection.

UC106861 (from Brandegee herbarium)- California Academy of Sciences/ Herbarium / Gilia androsacea/ var. crocea Eastwood n. var./ Blenheim, San Mateo Co., Cal./ Coll. Alice Eastwood, 19 May 1901.

US735823 (barcode 00110374)- FLORA OF CALIFORNIA/ Linanthus croceus Eastwood/ Blenheim/ San Mateo Co./ Alice Eastwood, 19 May [with the 1 in 19 struck through] 1901.

We note that "Blenheim" was a short-lived place name that was mapped ca. 2–3 miles north of Pillar Point on a Rand McNally & Co. map of California dated 1899. Blenheim apparently referred to a place at or near present-day Moss Beach.

We here designate **UC106861** as **lectotype** of *Linanthus parviflorus* (Benth.) Greene var. *croceus* Milliken; the name on the original label matches "var. of Gilia androsacea" in the protologue. The currently accepted name for the species with circumscription that includes UC106861 is *Leptosiphon croceus* (Eastw.) Strother & Kersh.

In protologue for *Linanthus croceus* Eastw., Bot. Gaz. 37: 442–443. 20 June 1904, Eastwood wrote, "This beautiful species was collected by the author May 9, 1901, near Pt. San Pedro, San Mateo county, California. It covered the ground for several acres, but was seen in no other place, and is probably a strictly local species." CAS393 (barcode 225240) accords with the Eastwood protologue for *L. croceus*; we consider CAS393 to be the holotype of *Linanthus croceus* Eastw. The currently accepted name for the species with circumscription that includes CAS393 is *Leptosiphon croceus* (Eastw.) Strother & Kersh.

Basionym for "*Leptosiphon croceus* (Eastw.) J.M. Porter & L.A. Johnson," Aliso 19: 80. 28 Jul 2000, was incorrectly cited as "*Linanthus croceus* Eastw., Pl. hartw., 325. 1849." We had thought that under Melbourne Code, Art. 41.6 (accessed 23 Feb 2016 [www.iapt-taxon.org/nomen/main.php]), citation of "Pl. hartw., p. 325. 1849," instead of "Bot. Gaz. 37: 442–443. 20 June 1904," as place of publication of the basionym could be treated as a bibliographic error and that "*Leptosiphon croceus* (Eastw.) J.M. Porter & L.A. Johnson," Aliso 19: 80. 28 Jul 2000, was a validly published name. Evidently, Art. 41.7 applies and "*Leptosiphon croceus* (Eastw.) J.M. Porter & L.A. Johnson" was not validly published in 2000. We publish the combination here:

Leptosiphon croceus (Eastw.) Strother & Kersh, **comb. nov.** Basionym: *Linanthus croceus* Eastw., Bot. Gaz. 37: 442–443. 20 June 1904.

We note that because collection date conflicts with protologues, CAS394 (barcode 00123068), *Alice Eastwood s.n.*, 2 May 1899, cannot be type of either *Linanthus parviflorus* (Benth.) Greene var. *croceus* Milliken, Univ. Calif. Publ. Bot. 2: 59. 10 May 1904, or *Linanthus croceus* Eastw., Bot. Gaz. 37: 442–443. 20 June 1904.

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GAMOCHAETA PENSYLVANICA (ASTERACEAE) IS ESTABLISHED IN THE NEW YORK FLORA

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ABSTRACT

Recent field work and study of herbarium specimens document *Gamochaeta pensylvanica* as an established element in the spontaneous flora of New York State. The species was first collected in New York in 1938, but the sole specimen was misidentified as *Gamochaeta purpurea*. *Gamochaeta pensylvanica* is reported here with specimens from Bronx, Kings, and Queens counties and observations from Nassau County. A key based on living and preserved specimens distinguishing *G. purpurea* from *G. pensylvanica* is provided.

Of the 12 species of *Gamochaeta* recognized in North America (Nesom, 2006), only *G. purpurea* (L.) Cabrera has previously been reported for New York state (Nesom 2006; Weldy et al. 2015), where it has been considered rare (S3) (Weldy et al. 2015).

In the last several years, collections identified as *Gamochaeta purpurea* from ruderal habitats in New York City and Long Island (Lamont & Glenn 2009) have suggested that it was not rare. In December 2015, GIS analysis of under-collected areas for the Central Park Flora Project led us to investigate the region around Sheep Meadow in the southwestern section of the park, where a small population of *Gamochaeta* (Figure 1) was observed. Upon examination and comparison to herbarium material identified by Nesom, Peter Michael, and Jorge Arriagada and keyed using recent publications (Haines 2011; Nesom 2004a, 2004b, 2006; Weakley 2015), we determined the species as

Gamochaeta pensylvanica (Willd.) Cabr. This led to a re-examination of recent reports of the genus in the vicinity of New York City as well as herbarium material at NY and BKL. The specimens document two species of *Gamochaeta* collected in New York state.

Gamochaeta purpurea was collected near Albany and Penn Yan, New York during the 19th Century. It has been collected twice in New York state since then — from between Sag Harbor and East Hampton, Suffolk Co. (29 Jul 1932, *Svenson 5269,* BKL) and from Southold, Suffolk Co. (27 Sep 1984, *Zaremba 1250*, BKL). The species is more common south and westward from New Jersey to Texas.

Gamochaeta pensylvanica appears to be adventive and expanding in the New York City region, where the plants are most often encountered in sidewalk medians, lawns, and weedy areas with low vegetation. It is widespread in ruderal habitats worldwide and in North America occurs primarily along the Atlantic and Gulf Coasts (Nesom 2004, 2006). The species is thought to be native to South America, where the genus is most abundant (Nesom 2004).

Specimens examined (*Gamochaeta pensylvanica*): **New York.** Bronx Co.: New York Botanical Garden, 21 Aug 1940, *Gilly 385* (NY). New York Co.: New York City, Central Park, Sheep Meadow, E side, 40.770429, -73.973586 (WGS84, ±25m), ca 22 m elev., 16 Dec 2015, *Atha, Alvarez, and Feeser 15390* (NY). Queens Co.: New York City, Forest Hills, between 71st Ave and Tennis Pl and between Dartmouth and Burns Sts, 40.719137, -73.845750 (WGS84, ±25m), ca 22 m elev., 18 Dec 2015, *Feder s.n.* (NY); Kissena Park, 19 Jul 2005, *Bennett 050191a* (BKL); Queens Village, 12 Aug 1989, *Delendick s.n.* (BKL); ibid, 21 July 1990, *Delendick s.n.* (BKL). Kings Co.: New York City, East Flatbush, Kings County Hospital, 16 Sep 1990, *Delendick s.n.* (BKL); Park Slope, 27 Aug 1989, *Delendick s.n.* (BKL); ibid, 4 Jul 1992, *Delendick s.n.* (BKL); along Kings Highway, Flatlands, 17 Aug 1989, *Delendick s.n.* (BKL).

The Gilly label from the Bronx County population does not include a description of the plant, local abundance or habitat information and the species is no longer extant at the New York Botanical Garden (Atha et al. 2016). The Central Park population consisted of about seven plants growing along the base of a chain-link fence between an asphalt path on the west side of The Mall and the lawn of Sheep Meadow (Figure 1). The plants varied in height from about 10 to about 25 centimeters tall and were a uniform pale green color with little or no color contrast between the upper and lower leaf surfaces. The plants were distinctive because on December 16 the plants were still quite green and fertile, despite the advanced season. In Queens County the plant is locally common in Rego Park and Forest Hills, where it occurs in small colonies of a few individuals. At Saint John's Cemetery in Middle Village, Queens Co. (40.718056, -73.863612), thousands of plants were observed growing together. The species was also seen growing in at least thirty separate localities, mostly in the vicinity of Forest Hills, but also in Flushing and Sunnyside, Queens County (Lamont & Glenn 2009). The species was observed and photographed in Fort Greene Park, Kings Co. on 10 September 2015. Scattered individuals were also observed spontaneously occurring in flower beds in New Hyde Park, Nassau County.

The Bronx specimen was originally identified as *Gnaphalium purpurem* by the collector in 1938 and was re-identified as *Gnaphalium pensylvanicum* by Peter Michael in 1978. *Gamochaeta purpurea* was reported from Central Park (Lamont & Glenn 2009), but no specimens were collected. Based on what we know from extant specimens, we believe the species seen in Central Park was *Gamochaeta pensylvanica*.

Figure 1. *Gamochaeta pensylvanica* in Central Park, New York Co., New York. The large lawn in the background is Sheep Meadow. Photo by Daniel Atha, 16 December 2015.

Key to *Gamochaeta* species in New York state

1. Basal leaves withering at anthesis; cauline leaves concolorous to weakly bicolorous, obovate, the bases cuneate, the adaxials arachnose; involucres 3–4 mm long; receptacles deeply crateriform; cypselae ellipsoid, 0.6–0.7 × 0.3 mm, minutely and sparsely papillose **Gamochaeta pensylvanica**

1. Basal leaves persistent at anthesis; cauline leaves strongly discolorous, spatulate, the bases long-attenuate, the adaxials sparsely arachnose to glabrous; involucres 4–5 mm long; receptacles flat to concave; cypselae oblong, 0.6–0.7 × 0.1–0.2 mm, papillose ..... **Gamochaeta purpurea**

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DOCUMENTING A *SOLIDAGO BICOLOR* × *S. BRENDIAE* HYBRID (ASTERACEAE: ASTEREAE) FROM NOVA SCOTIA

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ABSTRACT

Hinds (1984) reported a wild hybrid between *Solidago bicolor* and *S. canadensis* and from Cape Breton Island, Nova Scotia, Canada. A single herbarium sheet *Hinds 3828* (UNB) was examined and initially determined to include voucher specimens of *S. bicolor*, *S. bicolor* × *S. brendiae* and *S. brendiae*. A multivariate analysis of 52 specimens of the three species *S. bicolor*, *S. brendiae*, and *S. canadensis* and the putative *S. bicolor* × *S. brendiae* specimen was performed and confirmed that *S. brendiae* was the likely second parent, not *S. canadensis*. The plot of first and second axes canonical scores for all specimens including the hybrid indicated that the putative hybrid was likely an interspecific *Solidago bicolor* × *S. brendiae* hybrid as did several other traits not included in the analysis.

Hinds (1984) reported a collection of putative *Solidago bicolor* L. × *S. canadensis* L. from Cape Breton Island National Park, Nova Scotia, Canada (roadside halfway to first salmon pool on Chéticamp R., gravelly roadside, one large plant with both parents, 11 Aug 1980, *Hinds 3828* UNB). The herbarium sheet includes voucher shoots of the two putative parent taxa and the putative hybrid (Figs. 1-4). Based on the distribution of *S. canadensis* and *S. brendiae* Semple (Semple 2013; Semple et al. 2013; Semple, frequently updated), the possibility existed that the second parent was not *S. canadensis* but *S. brendiae*, which was only described in 2013. *Solidago bicolor* is a member of *S.* subsect. *Squarrosae* A. Gray, which includes species with club- or wand-shaped inflorescences (elongated lower inflorescence branches are also wand- or club-shaped), with petiolate or subpetiolate and broadly oblanceolate to obovate basal rosette and lower stem leaves generally much larger than the upper stem leaves and with phyllaries tending to be oblong and obtuse to rounded tipped (Semple & Cook 2006). *Solidago brendiae* and *S. canadensis* are members of *S.* subsect. *Triplinerviae* (Torrey & A. Gray) G.L. Nesom, which generally have secund pyramidal-shaped inflorescences, lower stem leaves that not the largest and usually not present at flowering. Also, lower and often mid and upper stem leaves of species of subsect. *Triplinerviae* have two prominent lateral veins that arise part way along the midvein; this is the "triple-nerved" condition of the subsection epithet. *Hinds 3828* was borrowed from UNB and morphological traits scored up for inclusion in a multivariate analysis of *S. bicolor*, *S. brendiae*, and *S. canadensis* var. *canadensis* specimens. The results of the analysis are presented below.

MATERIALS AND METHODS

In total, 52 specimens from the J.K. Morton personal herbarium (now deposited in ROM, MIN, UNB, and WAT in MT) were selected for inclusion in the analysis of 17 specimens each of *Solidago bicolor*, *S. brendiae*, and *S. canadensis* and one putative specimen of *S. bicolor* × *S. brendiae*. All traits scored are listed in Table 1. Specimens of *S. bicolor* came from Connecticut, Georgia, Maine, Maryland, New Hampshire, Nova Scotia, Ontario, Pennsylvania, Prince Edward Island, Québec, Virginia, and West Virginia. Specimens of *S. brendiae* came from New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, and Québec. Specimens of *S. canadensis* (var. *canadensis* only) came from Maine, Massachusetts, New Brunswick, Nova Scotia, New York, Ontario, Québec, and Vermont. Multivariate data on specimens of *S. brendiae* and *S. canadensis* were selected from specimens previously used in Semple et al. (2013).

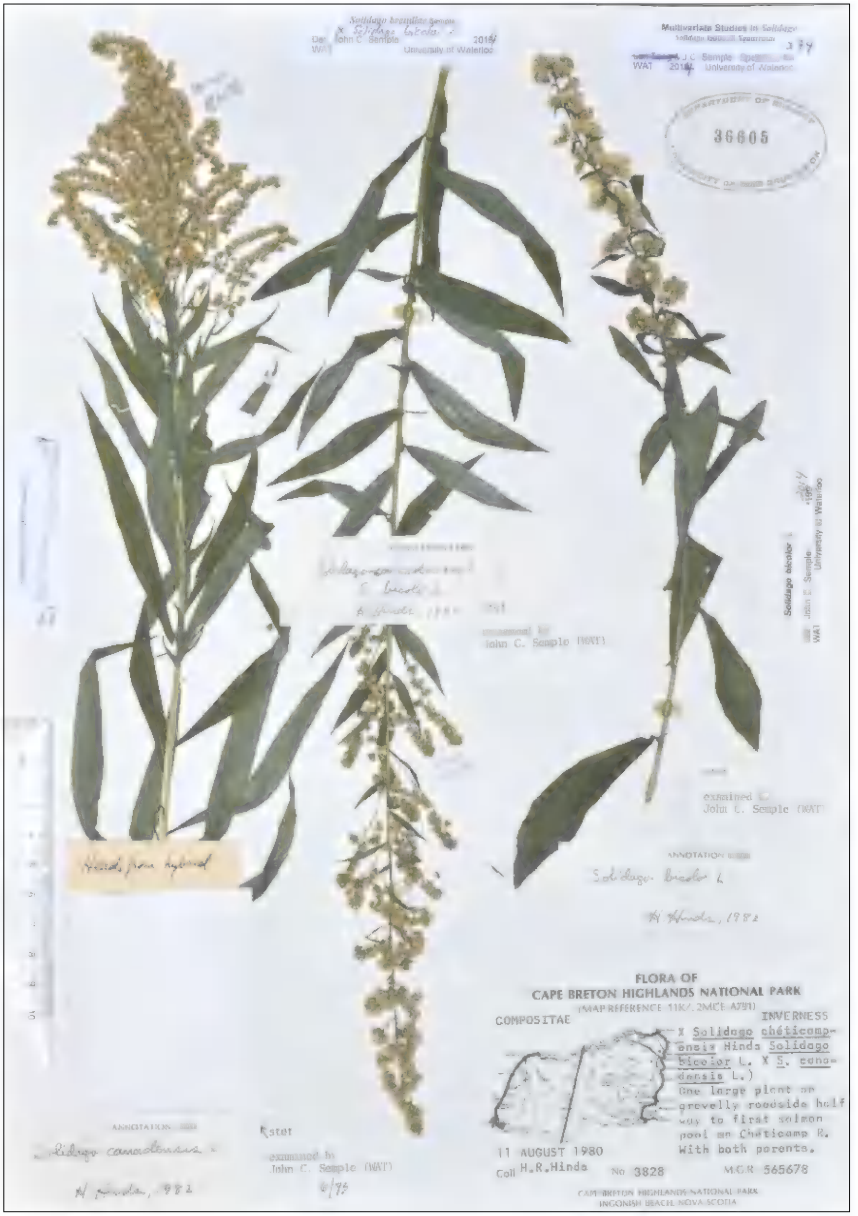

Figure 1. *Hinds 3828* (UNB); *Solidago brendiae*, *S. bicolor* × *S. brendiae*, and *S. bicolor* from Cape Breton Highlands National Park, Nova Scotia.

Figure 2. *Hinds 3828* (UNB): *Solidago bicolor* × *S. brendiae*. **A.** Upper portion of shoot. **B.** Lower stem leaves. **C.** Mid stem and leaf. **D.** Flowering heads. Scale bar = 1 cm in A and C; = 1 mm in B and D.

Figure 3. *Hinds 3828* (UNB): *Solidago bicolor*. **A.** Upper portion of shoot. **B.** Lower mid stem leaf. **C.** Mid stem and leaf. **D.** Flowering heads. Scale bar = 1 cm in A and C; = 1 mm in B and D.

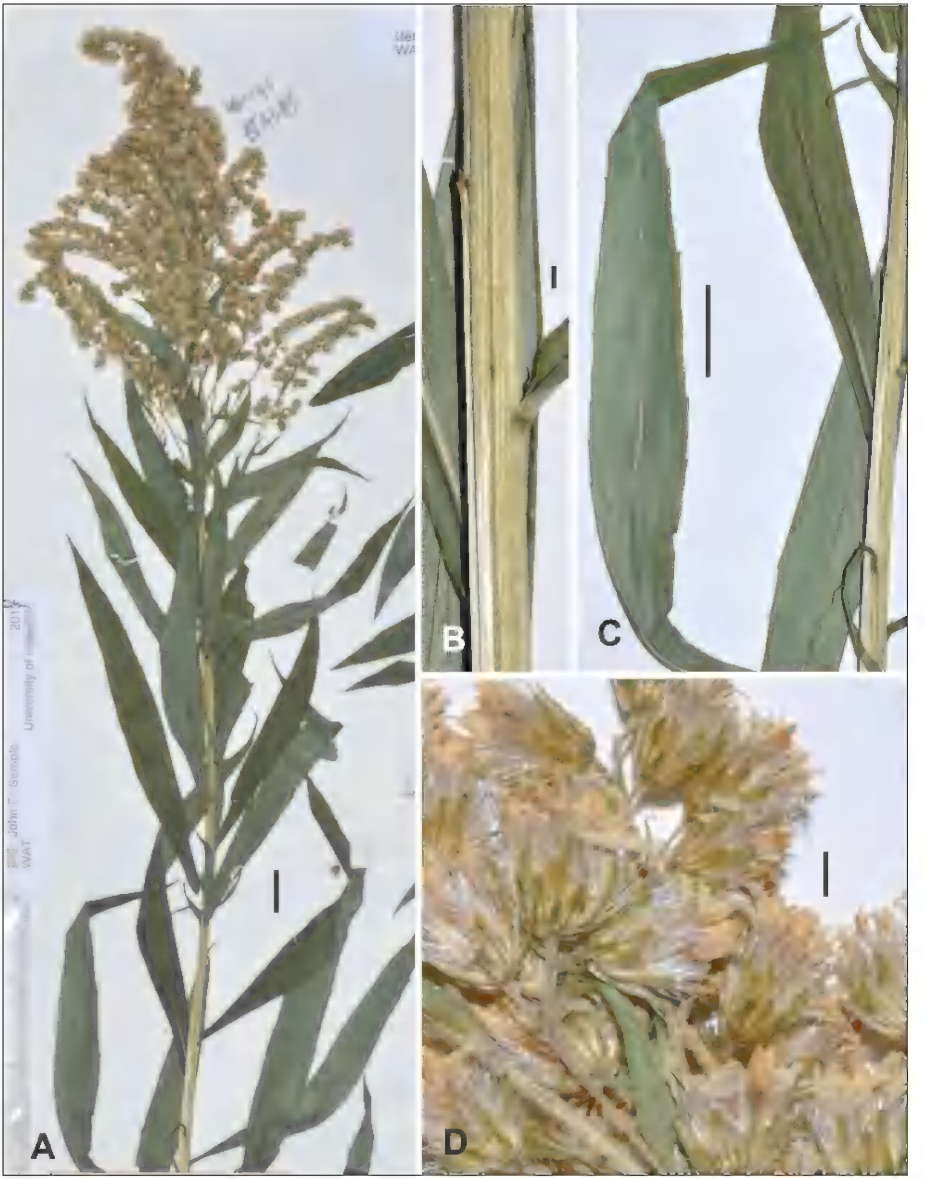

Figure 4. *Hinds 3828* (UNB): *Solidago brendiae*. A. Upper portion of shoot. B. Lower stem leaves. C. Mid stem and leaf. D. Flowering heads. Scale bar = 1 cm in A and C; = 1 mm in B and D.

Table 1. Traits scored for the multivariate analyses of *Solidago bicolor*, *S. brendiae*, and *S. canadensis* and one specimen of *S. bicolor* × *S. brendiae*.

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
BLFLN	Basal leaf length measured from the leaf base to tip(mm)
BLFPETLN	Petiole length of basal leaf- measured from the petiole base to tip of basal leaf (mm)
BLFWD	Basal leaf width measured at the widest point (mm)
BLWTOE	Basal leaf measured from the widest point to the tip(mm)
BLFSER	Basal leaf dentation-number of serrations of basal leaf
LLFLN	Lower leaf length measured from the leaf base to tip(mm)
LLPLETLN	Petiole length of lower leaf- measured from the petiole base to tip of the lower leaf (mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end(mm)
LLFSER	Lower leaf dentation-number of serrations of lower leaf
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf dentation-number of serrations of mid leaf
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end(mm)
ULFSER	Upper leaf dentation-number of serrations of upper leaf
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
IPHYLN	Inner phyllary length (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
RPUB	Number of pubescence per ray achene (mm)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)

Not all traits scored were included in the analyses. Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences between upper leaf traits and ray floret color were used to define a priori groups. Specimens of *Solidago bicolor* usually had lower stem leaves that were the largest on the shoot. Specimens of *S. brendiae* and *S. canadensis* lacked lower stem leaves and therefore traits on lower stem leaves were excluded. A Pearson pairwise correlation matrix was generated and only one trait of a pair of traits with a correlation value $|r| > 0.7$ was included in the analyses. The analyses included the following less correlated traits: MLFLN, MLFWD, MLFSER, CAPL, CAPW, INVOLHT, OPHYLL, RAYNUM, RSTRAPL, RSTRAPWD, and DISCNUM.

All analyses were performed using SYSTAT v.10 (SPSS 2000) following the methods of Semple et al. (2013). Initially STEPWISE discriminant analysis was used to select traits that most strongly separated the three a priori groups in N-dimensional hyperspace. Because the number of traits selected was less than N-1 where N equals the smallest sample size for any of the a priori groups there was no need to select traits and run a complete analysis subsequently. In this study, N-1=16 and so the results of the STEPDISC analysis are presented. A complete analysis using all 11 traits was also run for comparison. Classificatory discriminant analyses were run to place a posteriori the single hybrid specimen into one of the three a priori species level groups.

RESULTS

In the STEPWISE discriminant analysis of three species level a priori groups *Solidago bicolor*, *S. brendiae* and *S. canadensis*, the following eight traits listed in order of decreasing F-to-remove values were selected (F-to-remove): number of ray florets (28.00), involucre height (13.12), number of disc florets (11.89), inflorescence length (11.28), ray floret strap length (7.09), inflorescence width (6.72), mid lead length (5.70), and outer phyllary length (4.53). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of $p = 0.000$ that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicate the largest separations were between *S. bicolor* and *S. canadensis* (53.426) and between *S. bicolor* and *S. brendiae* (47.482). The smallest separation was between *S. brendiae* and *S. canadensis* (13.078).

In the Classificatory Discriminant Analysis of the three species level a priori groups *S. bicolor*, *S. brendiae* and *S. canadensis* the percents of correct classification were all 100%. The Classification matrix and Jackknife classification matrix are presented in Table 3. All 17 specimens of *S. bicolor* were placed a posteriori into the *S. bicolor* group with 100% probability. Fifteen of the 17 specimens of *S. brendiae* were placed a posteriori into the *S. brendiae* group with 97-100% probability; one was placed into the *S. brendiae* group with 91% probability; and one was into the *S. brendiae* group with 73% probability (27% to the *S. canadensis* group).

Table 2. Between groups F-matrix for the three a priori group analysis (df = 11, 38).

Group	*bicolor*	*brendiae*	*canadensis*
bicolor	0.000		
brendiae	47.482	0.000	
canadensis	53.426	13.078	0.000

Wilks' lambda
Lambda = 0.0214 df = 8 2 48
Approx. F= 29.8996 df = 16 82 prob = 0.0000

A two dimensional plot of CAN1 versus CAN 2 canonical scores for specimens of *Solidago bicolor, S. brendiae, S. canadensis*, and the single collection of *S. bicolor* × *S. brendiae* are presented in Fig. 5. The positions of the *S. bicolor* and *S. brendiae* specimens mounted with the hybrid on *Hinds 3828* (UNB) are indicated by P1 and P2, respectively. Eigen values on the first two axes were 12.321 and 2.506.

The results of the complete analysis using all 11 characters was overall similar but with a slight decrease the average probabilities of correct assignments a posteriori of specimens to *Solidago brendiae* and *S. canadensis*, including the *S. bicolor* × *S. brendiae* specimen to *S. brendiae* (93%). These additional traits were useful in the case of a few specimens but weakened the overall results in terms of group centroid separation. The full details are not presented here.

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Linear classification matrix

	bicolor	***brendiae***	***canadensis***	% correct
bicolor	17	0	0	100%
brendiae	0	17	0	100%
canadensis	3	0	17	100%
Total	17	17	17	100%

Jackknifed classification matrix

	bicolor	***brendiae***	***canadensis***	**% correct**
bicolor	17	0	0	100%
brendiae	0	15	2	88%
canadensis	0	1	16	94%
Total	17	16	18	94%

DISCUSSION

The results support the identification of the hybrid as *Solidago bicolor* × *S. brendiae*. Because a single specimen cannot be treated as an a priori group in discriminant analyses, the hybrid specimen was not assigned to an a priori group but was included in the a posteriori classificatory discriminant analysis, which assigned the specimen a posteriori to *S. brendiae* with 90% probability (10% to *S. canadensis*). On these results, the putative hybrid could be rejected as a hybrid. However, in the canonical discriminant analysis (a dimension reduction technique), the first and second canonical scores for the hybrid placed the specimen between the *S. bicolor* group of specimens and the *S. brendiae* group of specimens, but closer to the latter (Fig.5). The position of the hybrid is close to the two specimens of *S. brendiae* placed a posteriori in *S. brendiae* with the 73% and 91% probabilities. The specimens of the two parent taxa on *Hinds 3828* (UNB) are indicated in Fig.5 (P1 and P2); the hybrid is positioned on the diagram about half between these two specimens, which is where one would expect a hybrid to be placed on such a diagram.

A more traditional scatter plot diagram (e.g., see Fig. 13 in Semple and Semple 1977) could have been constructed and would have allowed the inclusion of traits difficult to score for inclusion in discriminant analyses. The rays of *Solidago bicolor* are white (Fig. 3D). The rays of the hybrid are lighter yellow in color (Fig. 2D) than those of the *S. brendiae* (Fig. 4D) and *S. canadensis* species, although this trait is less reliable on dried collections than the color difference would be on fresh plants in the field. The fresh rays of *S. brendiae* are the typical bright yellow of most goldenrods (see Fig 3E in Semple 2013). Hinds (1984) stated that "The hybrid occurred with both parents growing

nearby and combined the characteristics of both." I suspect that what caught the late Harold Hinds' attention was the lighter creamy yellow color of the rays of the hybrid. Ray color was not included as a trait in the discriminant analysis. The triple-nerved condition of the hybrid leaves was less obvious (Figs. 2B-C) than on specimens of the two species of subsect. *Triplinerviae* (Fig. 4C). Another obvious indicator of the hybrid condition would be the size and shape of lower stem leaves, which differ greatly between members of subsect. *Squarrosae* and those of subsect. *Triplinerviae* (Semple & Cook 2006). *Hinds 3828* does not include the lower portions of the stems of the hybrid shoot or its parents. Therefore, lower stem leaf traits were not available for comparison.

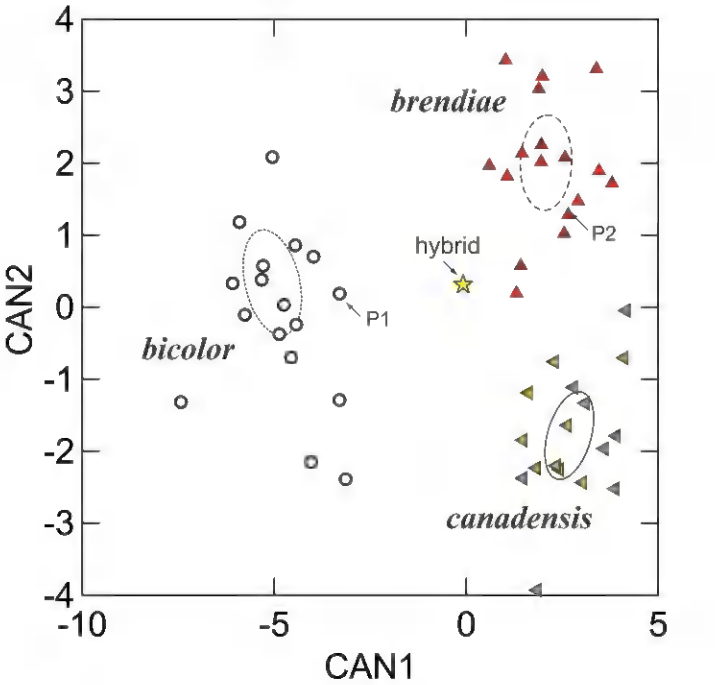

Figure 5. Plot of CAN1 versus CAN2 of specimens of *Solidao bicolor* (open circles; position of *Hinds 3828* UNB indicated by P1), *S. brendiae* (red triangles; position of *Hinds 3828* UNB indicated by P2), *S. canadensis* (green triangles), and a *S. bicolor* × *S. brendiae* specimen (yellow star).

There is also the possibility that the hybrid specimen is not an F1, but is an F2 backcross of an F1 individual with the *Solidago brendiae* parent. Such a specimen would have more traits in common with *S. brendiae* than the hybrid. No experimental hybrids were created as part of this study. Additional sympatric populations of *S. bicolor* and *S. brendiae* need to be explored in the field to assess whether or not F2 plants occur or hybridization is restricted to just F1 interspecific hybrids.

The known chromosome numbers for *Solidago bicolor*, *S. brendiae* and *S. canadensis* are all diploid, $2n = 18$. Hybridization would be facilitated by the parents having the same ploidy level.

Also, the lack of known polyploids in the three species means that ploidy level was not a factor in differences between morphological traits of the three species and the hybrid.

My conclusion is that Hinds did collect an interspecific hybrid in 1980 but he was understandably wrong in assuming it was a cross between *Solidago bicolor* and *S. canadensis*. *Solidago brendiae* was not described until recently (Semple 2013) and would not have been an option for him to choose as a parent at the time he made the collections and published his interpretation in 1984. Documenting statistically or experimentally the occurrence of interspecific hybridization in *Solidago* needs to be done for multiple other putative cases.

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SANSEVIERIA HYACINTHOIDES (AGAVACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Sansevieria hyacinthoides is reported here as naturalized in Cameron and Hidalgo counties of the lower Río Grande Valley of far south Texas, where it has formed relatively dense, rhizomatous colonies along resacas. The species does not appear to present an invasive problem in Texas, possibly due to less than optimal moisture.

Sansevieria hyacinthoides (L.) Druce, a native of Mozambique, Namibia, and South Africa, is a commonly used ornamental in yards and greenhouses in warm climates. It regularly escapes and may spread by seeds and rhizomes and in discarded garden waste. The species was introduced to Florida in about 1800 as an ornamental and fiber crop (Brown 2013). It has also become naturalized in Puerto Rico, the Virgin Islands, and Australia. *Sansevieria* is placed in Agavaceae (Wunderlin 1998; Hess 2002) or in Dracaenaceae (IPNI 2016) or Asparagaceae (Tropicos 2016).

Based on the following specimens collected in Cameron and Hidalgo counties of the lower Rio Grande Valley of south Texas, we report *Sansevieria hyacinthoides* as new to the spontaneous flora of Texas. Common names of the species include bowstring hemp, snake plant, and mother-in-laws tongue.

Texas. Cameron Co.: 0.2 mi N of Texas Hwy 227 and Salida De Luma Ave. on Texas Hwy 227, W side of Texas Hwy 227, 8 Dec 2015, *Singhurst, Allen, Pons, and Rodriquez 21035* (BAYLU); Hidalgo Co.: Estero Llano Grande State Park, 0.3 mi S of jct of E Mile 5 North Rd. and FM 1015, E side of FM 1015, 14 Jan 2016, *Singhurst 21036* (BAYLU). Figures 1, 2.

The *Sansevieria* population in Cameron County consists of what appear to be several hundreds of individuals in the understory of native thorn scrub along a resaca ('dry river'), although it is difficult to determine what constitutes an individual plant. The underground system consists of fleshy rhizomes and fibrous roots that produce a dense groundcover that seemingly limits competition. Associated flora include *Ehretia anacua*, *Celtis laevigata*, *Celtis pallida*, *Forestiera angustifolia*, *Rivina humilis*, and *Malvaviscus arboreus* var. *drummondii*. The associated flora of the Hidalgo County population include *Ebenopsis ebano*, *Ehretia anacua*, *Guaiacum angustifolium*, *Karwinskia humboldtiana*, *Verbesina microptera*, *Rivina humilis*, and *Chiococca alba*.

Figure 1. *Sansevieria hyacinthoides*, Cameron Co., Texas. Photo by Jason Singhurst, 8 December 2015.

Figure 2. *Sansevieria hyacinthoides*, Cameron Co., Texas. Photo by Jason Singhurst, 8 December 2015.

The plants typically flower from December to June. The berry-like fruits are orange to reddish in color, about 6 mm in diameter, and contain 1–3 hard, globular seeds (Brown 2013). Fruit color seems to indicate, in our opinion, dissemination by birds.

Sansevieria hyacinthoides is naturalized in the southern tip of peninsular Florida (about 25º to about 29.5° north latitude), as determined from distribution map in Kartesz (2016). Brown (2013) reported that the plant has invasive qualities, which basically agrees with Wunderlin's (1998) statement that the species occurs in disturbed hammocks. The species occurs at similar latitudes in both Florida and Texas, but with the Texas occurrences limited to a narrow band near the Rio Grande River. While yearly average temperatures are nearly the same (about 23° C in the Texas locations, and 20-25º C in Florida) the major difference is annual precipitation. Florida averages about 157 cm per year in the south and about 120 cm for the northern occurrences in that state. Precipitation in the Texas areas of occurrence is about 70 cm for Cameron County (Brownsville) and 61 cm for Hidalgo County (Edinburg) (US Climate Data 2016). Lower precipitation in Texas may restrict *Sansevieria* to areas (such as resacas) where water may accumulate.

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A GUIDE TO THE NATURALIZED *NARCISSUS* IN ARKANSAS

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ABSTRACT

Eleven species and interspecific hybrids of *Narcissus* occur outside of cultivation in the Arkansas flora, or in a few cases at least they are long–persistent subsequent to cultivation. Three *Narcissus* taxa, *N. papyraceus* Ker–Gawl., *N. × tenuior* Curt., and an *N. jonquilla* hybrid cultivar, presumably of garden origin, are documented for their first occurrences outside of cultivation in the state. Voucher specimen data are included for the first occurrence records. One additional species of *Narcissus*, *N. bulbocodium* L., also is included because it has been observed persistent from cultivation and increasing in numbers via vegetative production of bulblets (lateral bulbs). A dichotomous key for identification of *Narcissus* taxa is provided, along with state distributions and full–color photos.

The genus *Narcissus*, in the Amaryllidaceae (sometimes merged within the Liliaceae) family, is native predominantly to Europe, with a few species in Asia and northern Africa (Webb 1980; Grey–Wilson & Mathew 1981; Blanchard 1990; Ji & Meerow 2000). The Iberian Peninsula, and more precisely Spain, is regarded as the epicenter for species diversity (Blanchard 1990). The number of species attributed to the genus varies, depending on classification, from about 25–30 species and hybrid taxa (Bailey & Bailey 1976; Webb 1980) to upwards of 60 species (Ji & Meerow 2000), although thousands of horticultural varieties and forms have been recorded (Kington 1998; American Daffodil Society 2010). The taxonomy of the genus is difficult because of the frequency of natural hybridization among the species, along with extensive artificial selection, cultivation, escape, and naturalization (Webb 1980).

Extensive hybridization and horticultural selection have resulted in commercial *Narcissus* cultivars that are in most cases larger and more robust than their parental species, and have given rise to a tremendous level of morphological variation among cultivars (Bailey & Bailey 1976; Hanks 2002), which further contributes to taxonomic ambiguity in the genus. Many *Narcissus* taxa are long–persistent subsequent to cultivation and eventually provide the appearance of naturalization (Straley & Utech 2002). In the USA, including Arkansas, numerous species, hybrids, and cultivars of *Narcissus* are commonly grown and a number have become naturalized in the flora. Naturalized *Narcissus* have traditionally been under–collected and misidentified by field botanists (Spaulding & Barger 2014) and are thus sometimes under–represented in collections and floristic treatments. The bulbs of *Narcissus*

are poisonous, containing the phenanthridine alkaloids narcissine and lycorine, at least one glycoside, and needle–shaped acicular crystals of calcium oxalate (Burrows & Tyrl 2001; Hanks 2002).

Eleven *Narcissus* species and hybrid taxa are spontaneous to naturalized, or at least regularly persistent from cultivation in Arkansas (Gentry et al. 2013; Serviss, unpublished data). Five of these – – *N. jonquilla*, *N. papyraceus*, *N. poeticus*, *N. pseudonarcissus*, and *N. tazetta* — are considered distinct, sexually reproducing species, whereas five taxa –– *N. × incomparabilis*, *N. × intermedius*, *N. × medioluteus*, *N. × odorus*, and *N. × tenuior* –– are intersectional hybrids produced from combinations of species one through five. These hybrids are sexually sterile, but because of extensive cultivation combined with asexual production via bulblets (lateral bulbs—Fig. 1) and various "adventive" methods of propagule dispersal (discussed subsequently) are often as widespread outside of cultivation as their progenitor species (Serviss, unpublished data). Furthermore, long–persistent or spontaneous/naturalized plants of an *N. jonquilla* cultivar of hybrid origin have been collected from a few locations in the state.

One additional species of *Narcissus*, *N. bulbocodium,* also is included in this treatment. *Narcissus bulbocodium* has not been documented outside of cultivation in Arkansas to date; however, it is persistent from cultivation and appears to be increasing in numbers at one location via vegetative reproduction. *Narcissus bulbocodium* also is naturalized in a number of other southern states, including adjacent Louisiana (Thomas & Allen 1993; Nesom 2010; Spaulding & Barger 2014; Weakley 2015; USDA, NRCS 2016) and should be expected outside of cultivation in Arkansas.

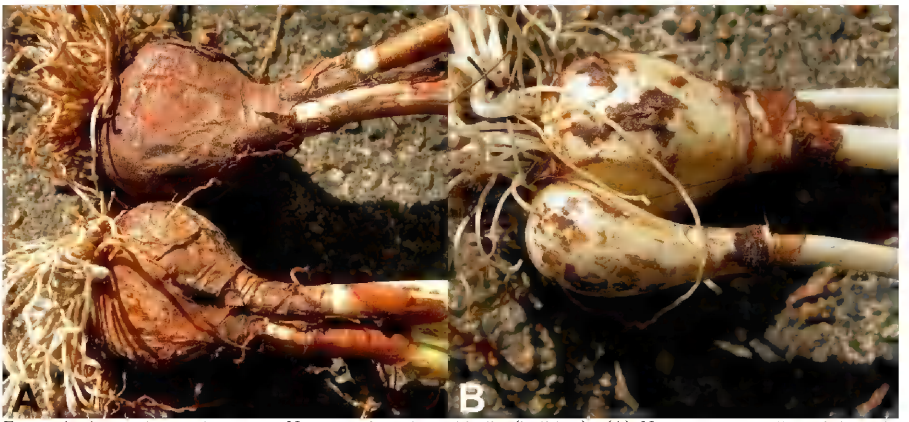


Figure 1. Asexual reproduction in *Narcissus* from lateral bulbs (bulblets). (A) *Narcissus jonquilla* with lateral bulbs that are still enclosed within the original tunic. (B) *Narcissus pseudonarcissus* (probably, as the plants were sterile when the photograph was taken) showing a well–developed lateral bulb (small, lower bulb in the photograph)—notice that it is still attached to the original (parent) bulb.

Of course, the initial presence of *Narcissus* plants in Arkansas is ultimately tied to humans; however, subsequent establishment and naturalization of *Narcissus* in the state's flora has occurred because of a combination of factors, including asexual and sexual reproduction, along with various anthropogenic activities. *Narcissus* plants may appear as naturalized, or they may be distributed to novel places in the flora and subsequently persist or naturalize through one or more of the following ways (Fig. 2): (1) abandonment and subsequent deterioration of old home sites (provides the illusion of naturalization in that area); (2) dispersal/transport of propagules, such as seeds, bulbs, or whole

plants to different areas via gravity, water, erosion, animals, soil movement, or agricultural/horticultural practices; and (3) intentional or inadvertent distribution by people. All of the aforementioned probably contribute to the extremely widespread distribution of *Narcissus* taxa in Arkansas and elsewhere in the USA.

Figure 2. Naturalized plants of *Narcissus jonquilla* on a roadside in Saline County, Arkansas. Although spontaneous, their source of origin is unknown (photo credit Jim Keesling).

The photographs in Fig. 3 show plants of *Narcissus pseudonarcissus* in a pasture in Bismarck, Arkansas. These plants have been present in this pasture since prior to the 1960s; originally, this area was an old home site (the *N. pseudonarcissus* plants were introduced and planted sometime prior to that time). The current distribution of the plants reflects a pattern that is commonly observed when bulbs are transported from one place to another via disking, plowing, or other soil disturbance activities generated from agricultural machinery, which occurred in this pasture 40 to 50 years ago. Although seed production likely occurs among these plants, apparently only minimal establishment is occurring in this fashion (Fig. 3B). Over time, one or a few plants will produce large, tightly packed clumps via asexual/vegetative production of bulblets from larger, subterranean bulbs. Hence, these small, isolated plants shown in Fig. 3B were probably not produced vegetatively.

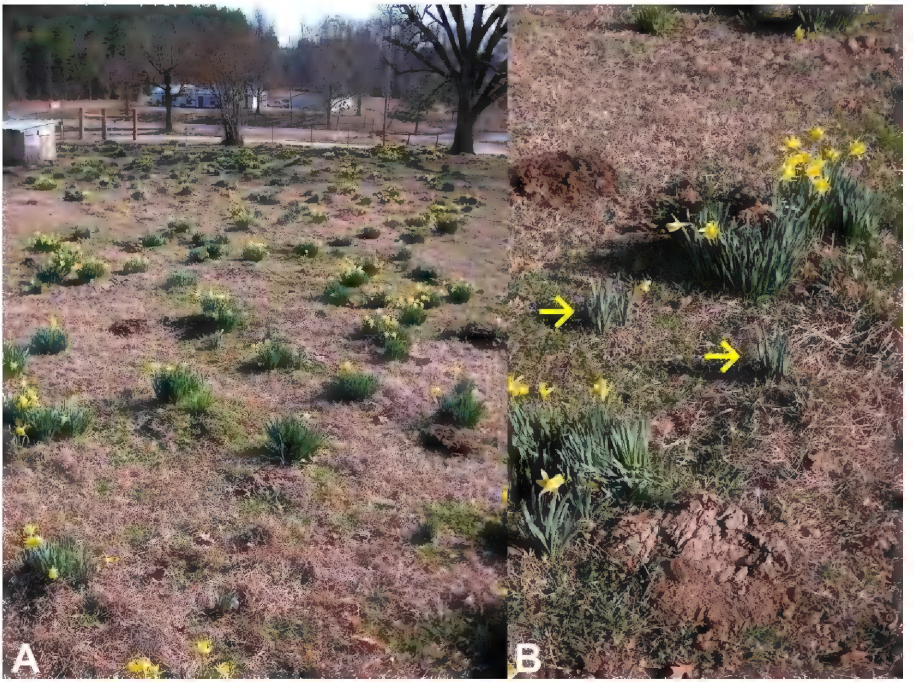


Figure 3. Plants of *Narcissus pseudonarcissus* in a pasture in Bismarck, Arkansas. Their origin is uncertain but plants are spreading vegetatively via bulblets and also possibly via seeds. (A) View of a portion of the pasture. (B) Two small, isolated clumps of "spontaneous" plants that obviously have been produced only in the recent past are indicated by yellow arrows.

Figure 4. Naturalized plants of *Narcissus pseudonarcissus* in a disturbed woods in Bismarck, Arkansas.

Figure 5. Spontaneous plants of *Narcissus pseudonarcissus*. (A–B) Two separate sets of small, spontaneous plants of *N. pseudonarcissus* in a disturbed woods in Bismarck, Arkansas. These plants likely were produced via seeds.

The photographs in Figs. 4–5 are of a wooded area immediately adjacent to the aforementioned pasture, where several decades ago, the pasture was bulldozed, and soil containing bulbs was transported to the wooded area. The transported bulbs subsequently established, and over time, the founder plants gave rise to an extensive population with numbers of individuals much in excess of that shown in the photograph. Again, while asexual reproduction also has been the predominant factor in increasing the number of plants in this area (notice the clumps — these would have started from only one to a few bulbs), seed production likely also is occurring (notice the small plants in Fig. 5; of course, the activity of burrowing animals also could potentially be the cause of these small plants through redistribution of the soil from digging or burrowing where bulbs are separated from the main clump and moved to an adjacent location).

The plants in Fig. 6 are in a pasture in the vicinity of Donaldson, Arkansas, where, via disking activities by farm machinery, cultivated plants were redistributed, forming a mosaic pattern of different kinds of *Narcissus*. One of these, a sterile, interspecific hybrid (*N. × odorus*) is incapable of seed production; however, it has still increased its numbers through vegetative reproduction.

The photographs in Figs. 7–8 show a pasture near Friendship, Arkansas with a somewhat similar pattern as observed in Donaldson. Although the method of spread is not known for these plants, because the plants are all *N. × medioluteus*, another sterile, interspecific hybrid, it is reasonable to surmise, at least in part, that the observed pattern of plants was created through mechanical redistribution of soil and bulbs via disking. Interestingly, a single plant of *N. × odorus* also was growing among the *N. × medioluteus* plants at this site.

Figure 6. Plants of *Narcissus pseudonarcissus* and *N. x odorus* in a pasture in the vicinity of Donaldson, Arkansas. The observed pattern of plants stems from once cultivated plants of these species that later were redistributed in the pasture via disking.

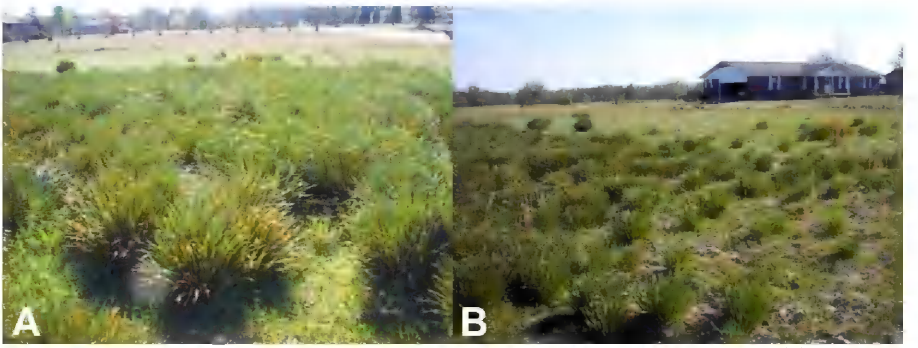


Figure 7. Plants of *Narcissus x medioluteus* in a pasture in the vicinity of Friendship, Arkansas. (A) Evidence of long–term vegetative reproduction via bulblets (notice the large diameter, tightly crowded clumps of plants). (B) Several smaller clumps of *N. x medioluteus* plants at the edge of the population; possibly distributed at a later time to this portion of the pasture via soil movement.

Figure 8. Plants of *Narcissus x medioluteus* in a pasture in the vicinity of Friendship, Arkansas. Their origin is uncertain but plants are spreading vegetatively via bulblets. These plants have been in the pasture for a number of years.

Key to Species of *Narcissus* Typically Encountered in the Arkansas Flora as Naturalized or Persisting Subsequent to Cultivation

In regard to identification of *Narcissus*, it is important to note that certain characteristics, such as flower size and coloration, position and shape of floral organs (perianth segments or corona), and leaf width, may be highly variable within a species, or even sometimes among individuals of the same population (Blanchard 1990). Fluctuations in environmental conditions, such as excessive or too little moisture, may contribute to differences in flower morphology if the plant is exposed to such during flower development. Furthermore, with age, flowers may change in color, or floral organs or the flower itself may shift in position. For example, perianth segments may become more reflexed or flowers may shift from drooping to ascending (Blanchard 1990). Flowers also will continue to grow and enlarge once they emerge from the spathe.

Please also consider that the following key should only be used with plants that are encountered as spontaneous to naturalized or clearly persisting from cultivation. Most of the modern cultivars and hybrids commonly found in cultivation will not key properly here, or if keyed, may cause identification errors.

1. Flowers "doubled"—corona not cuplike or tubular, but instead, dissected into numerous segments and often most or all of the stamens sterile and petaloid; plants sterile.

2. Leaves terete to subterete or concave and channeled.

3. Leaves terete to subterete ..... **Narcissus jonquilla**
3. Leaves concave with an obvious channel along their length ..... **Narcissus X odorus**

2. Leaves flattened.

4. Flowers green maturing to yellow–green or sometimes yellow, segments of the corona yellow, occasionally some also orange; lobes of the corona as long or longer than the perianth ..... **Narcissus pseudonarcissus**
4. Flowers creamy–yellow to yellow, segments of the corona orange; lobes of the corona shorter than the perianth segments ..... **Narcissus X incomparabilis**

1. Flowers typical—corona cuplike or tubular; stamens with typical anthers and filaments present—not petaloid; plants fertile species or sterile interspecific hybrids.

5. Leaves narrow, usually 7(8) mm or less wide, terete, subterete, or concave (curved inward and somewhat flattened on one side), or with a shallow groove on the adaxial surface—these leaves may be somewhat flattened.

6. Perianth segments linear, or lanceolate–elliptic and deflexed away from the corona; leaves 3 mm or less wide (usually 1–2 mm wide) ..... **Narcissus bulbocodium**
6. Perianth segments much wider; at least some leaves 3 mm wide or wider.

7. Flowers (3.5)4 cm wide or wider; perianth segments narrowly elliptic or ovate–elliptic, or subrotund or broadly ovate to ovate–elliptic, if rotund or broadly ovate to ovate–elliptic, than often with dark yellow and pale yellow to cream coloration on the perianth segments.

8. Corona and perianth concolorous (the same color); perianth segments narrowly elliptic to ovate–elliptic, widely spaced and not overlapping with one another or only so basally, uniformly yellow, typically less than 1.5 cm wide; flowers occasionally with only 3–5 perianth segments present (commonly encountered taxon) ..... **Narcissus X odorus**
8. Corona darker in color (sometimes only slightly so) than the perianth segments; perianth segments broadly ovate, ovate–elliptic, or subrotund, clearly overlapping, often two–toned with dark yellow and whitish to cream coloration on the same segment, especially in older flowers, segments of perianth typically 1.5 cm wide or wider (occasionally encountered taxon) ..... **Narcissus sp. (N. jonquilla** hybrid cultivar**)**

7. Flowers 1–3.3(3.5) cm in diameter; perianth segments rotund or broadly elliptic to ovate, about as long as wide.

9. Perianth and corona essentially concolorous; bright yellow or golden–yellow, occasionally corona slightly darker than perianth; perianth segments with the margins not folded or curved; leaves essentially terete to subterete, sometimes also with a narrow flattened area or groove along the adaxial surface ..... **Narcissus jonquilla**
9. Perianth yellow, pale yellow, cream–colored, or nearly white, corona orange, yellow, or cream–colored, always darker than the perianth; perianth segments with the margins

folded or not; leaves concave (curved inward and somewhat flattened on one side) or mostly flattened.

10. Flowers 3–7 per inflorescence; at least some of the perianth segments with the margins folded or curved inward, segments yellow; corona deep yellow to orange ..... **Narcissus X intermedius**
10. Flowers 1–2(3) per inflorescence; perianth segments without the margins folded inward, segments pale yellow to almost white; corona lemon yellow ..... **Narcissus X tenuior**

5. Leaves flattened, generally 7 mm wide or wider (sometimes narrower than 7 mm in *N. papyraceus*, *N. poeticus*, and *N. tazetta*, but then clearly flattened).

11. Corona as long or longer than the perianth segments ..... **Narcissus pseudonarcissus**
11. Corona clearly shorter than the perianth segments.

12. Flowers (2)4–15(20) per umbel, 2–5(5.5) cm or less in diameter, strongly fragrant.

13. Corona yellow or orange and clearly darker in color than the perianth ..... **Narcissus tazetta**
13. Corona white and perianth white, or corona occasionally off–white to very pale creamy–white and perianth segments white ..... **Narcissus papyraceus**

12. Flowers 1–3(4) per umbel, 4.5 cm or more in diameter, fragrant or not.

14. Flowers solitary.

15. Corona much less than one-half as long as the perianth segments, margin of corona red and sometimes scarious, rarely lacking the red pigmentation and margin only scarious; perianth white to very pale creamy–white ..... **Narcissus poeticus**
15. Corona one–half to three–quarters as long as the perianth segments, margin of corona not red or scarious; perianth usually pale yellow, rarely white ..... **Narcissus X incomparabilis**

14. Flowers 2(3) per inflorescence, occasionally an inflorescence may have 1 or 4 flowers.

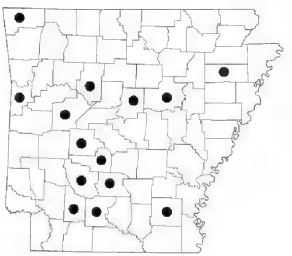
16. Perianth white, segments usually with a small amount of yellow coloration at the base adjacent to corona, corona yellow; leaves completely flattened ..... **Narcissus X medioluteus**
16. Perianth bright to pale yellow, sometimes two–toned with bright and pale yellow coloration, corona yellow to orange; leaves often concave at least along the upper one–third to one–half ..... **Narcissus sp. (N. jonquilla** hybrid cultivar**)**

Narcissus bulbocodium L. – HOOP–PETTICOAT DAFFODIL (Fig. 9)

Narcissus bulbocodium is native to open and rocky areas of Portugal, Spain, and France (Webb 1980). It is unlike other species of *Narcissus* in the state in that the perianth segments are linear. *Narcissus bulbocodium* is occasionally planted in Arkansas but has not been documented outside of cultivation in the state. It has, however, been documented outside of cultivation in Alabama, adjacent Louisiana, and North Carolina (Thomas & Allen 1993; Spaulding & Barger 2014; Weakley 2015), and should be expected outside of cultivation in Arkansas. Disturbed woods, woodland edges, roadsides, and naturalized or persisting in lawns. Flowering February–April.

Figure 9. *Narcissus bulbocodium.* (A & C) Flowers. (B) Plants and leaves.

Narcissus x incomparabilis Mill. – PEERLESS DAFFODIL; NONSUCH DAFFODIL (Figs. 10–11)



Narcissus x *incomparabilis* is a sterile, intersectional hybrid between *N. poeticus* and *N. pseudonarcissus* that is native to France and probably of natural origin (Webb 1980). This taxon is vigorous and long–persistent subsequent to cultivation, often spreading vegetatively via bublets, and is one of the most commonly encountered *Narcissus* in Arkansas. Plants of *N. x incomparabilis* are easily confused with *N. pseudonarcissus* because of the large, solitary flowers and flattened, glaucous leaves; however, it may be distinguished from *N. pseudonarcissus* by its corona, which is only about one–half to three–quarters as long as the perianth segments.

In contrast, the flowers of *N. pseudonarcissus* have a corona that is as long or longer than the perianth segments. Disturbed woods, woodland edges, pastures, fields, roadsides, and old home sites. Flowering February–April.

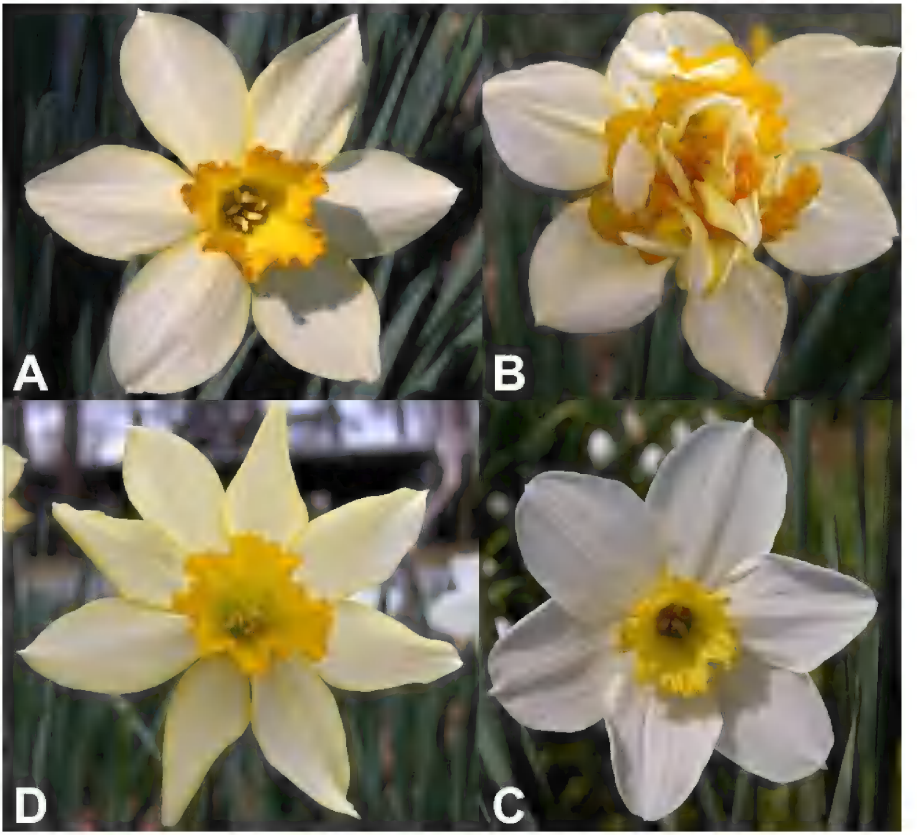
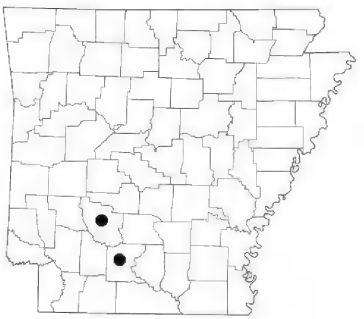


Figure 10. *Narcissus x incomparabilis*. (A–D) Flowers (Fig. B is of a "doubled" flower where the corona is divided and at least some of the stamens have been modified to form petals; Fig. C shows a white-colored flower form of *N. Xincomparabilis*, which is occasionally encountered; Fig. D shows a flower with additional perianth segments above the 6 that are typical—*N. Xincomparabilis* occasionally produces flowers with 7 or 8 perianth segments and up to as many as 12 have been observed in Arkansas plants).

Figure 11. *Narcissus* x *incomparabilis*. (A) Bulb and roots. (B) Plants. (C) Hymenopteran on flower.

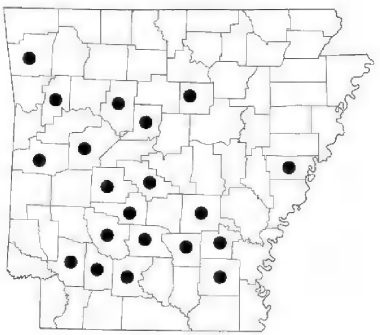
Narcissus x intermedius Loisel. – STAR JONQUIL (Fig. 12)



Narcissus x *intermedius* is a sterile, intersectional hybrid between *N. jonquilla* and *N. tazetta* that is native to the Mediterranean region; it is perhaps a naturally occurring hybrid (Webb 1980). *Narcissus* x *intermedius* is fairly similar in appearance to *N. jonquilla*; however, it may be distinguished from *N. jonquilla* by its channeled, concave leaves, orange–colored corona that is darker than the perianth, and perianth segments that are folded inward at their margins. In contrast, *N. jonquilla* has terete to subterete leaves, generally concolorous flowers with a yellow corona, and perianth segments that are generally not folded along the margins. The two species, however, are easily confused without close examination, especially when viewing herbarium specimens. *Narcissus* x *intermedius* is rarely encountered outside of cultivation in Arkansas, although it is probably more common in the flora than current records indicate. Pastures, fields, roadsides, and old home sites; tolerant of periodically wet soils. Flowering February–March; flowers fragrant.

Figure 12. *Narcissus* x *intermedius*. (A) Flowers and inflorescence. (B) Plants. (C) Close–up of flower; notice that the corona is darker in color than the perianth segments, which aids in distinguishing it from *N. jonquilla*. (D) Bulb and roots.

Narcissus jonquilla L. – JONQUIL (Figs. 13–14)

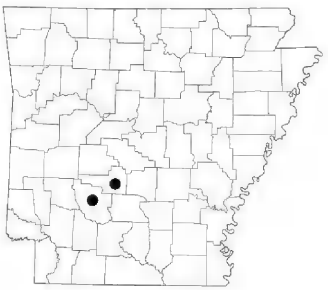


Narcissus jonquilla is a narrow–leaved and dainty species of *Narcissus* with strongly fragrant flowers that is native to open and damp places of Portugal and Spain (Webb 1980). It is extensively cultivated for its extremely fragrant flowers, which are sometimes used in perfumery, and it is naturalized in many areas of Europe and the USA (Webb 1980; Straley & Utech 2002). *Narcissus jonquilla* is one of the most commonly cultivated *Narcissus* species in Arkansas and is regularly encountered outside of cultivation in the state. It probably naturalizes via seed production as well as asexually, as plants readily produce seed in Arkansas (Fig. 13D). The flowers of *N. jonquilla* are typically concolorous, where the perianth segments and corona are the same color; however, plants are occasionally encountered with flowers where the corona is darker in color than the perianth segments. *Narcissus jonquilla* is tolerant of periodically wet soils and readily naturalizes in lawns and other open, disturbed sites. Disturbed woods, woodland edges, hillsides, pastures, fields, roadsides, lawns, and old home sites. Flowering February–April. Fruiting April–June.

Figure 13. *Narcissus jonquilla*. (A–B) Flowers and inflorescences. (C) Mature fruit. (D) Mature fruit and seeds (from Arkansas plants of *N. jonquilla*). (E) Bulb and roots. (F) Hymenopteran on flowers.

Figure 14. *Narcissus jonquilla*. (A) Spontaneous juvenile plant from seed. (B) Mature fruits and infructescence. (C) Plants.

Narcissus sp. (*N. jonquilla* hybrid cultivar) (Fig. 15)



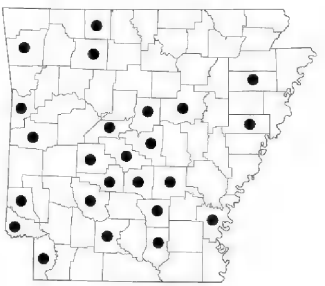
This *Narcissus* taxon has small to medium–sized (ca. 4–5.5 cm in diameter), yellow–colored, sweetly fragrant flowers that generally occur 2–3 per inflorescence, although solitary flowers also are sometimes produced. The corona is slightly darker in color than the perianth. These plants approach the growth form and floral morphology of the *N. jonquilla* hybrid cultivars 'Circuit', 'Penpol', 'Stratosphere', and 'Trevithian', although nevertheless seem possibly distinct from them. The leaves are linear, concave and channeled and somewhat similar to those of *N.* × *intermedius* and *N.* × *odorus*; however, they are often wider and more flattened. This taxon is a robust and showy plant that is occasionally cultivated but long–persistent from cultivation and possibly sparingly naturalized in Arkansas. The pale, nearly white to whitish cream areas of the perianth often develop as the flowers age. This taxon has not previously been recorded from Arkansas. Disturbed woods, fields, roadsides, lawns, and old home sites. Flowering March–April.

Voucher specimens. **Arkansas**. Clark Co.: Arkadelphia, along Hwy I–30 East, adjacent to intersection of Professional Drive and Pine Street, disturbed roadside along fencerow, one clump of isolated, "spontaneous" plants growing ca. 1–1.5 m away from hundreds to possibly thousands of

plants along fencerow that apparently were long–persistent from cultivation—these plants appeared to be increasing vegetatively via bulblets, 12 Mar 2016, *Serviss 8213* (HEND); Arkadelphia, Walnut Street, about 500 yards W of 26th Street, disturbed woods and adjacent yard, plants present and persisting or possibly escaping into woods from what appears to be originally cultivated plants, 3 Mar 2002, *Serviss 5079* (HEND); Okolona, Junction 51 on Hwy 82, roadside and adjacent semi–disturbed field, a few plants, possibly naturalized or long–persistent from cultivation, 3 Apr 2002, *Serviss 5083* (HEND). Hot Spring Co.: Hwy 128 E, about ¼ mi S of Caney Road, disturbed roadside, three clumps of naturalized plants, 21 Mar 2003, *Serviss 5119* (HEND).

Figure 15. *Narcissus* sp. (*N. jonquilla* hybrid cultivar). (A) Flowers and inflorescences. (B) Plants (the flowers on these plants are young and have little to no fading of the perianth segments). (C) Close–up of flowers showing fading on perianth segments.

Narcissus x medioluteus Mill. – TWIN SISTERS (Fig. 16)



Narcissus x *medioluteus* is a sterile, intersectional hybrid between *N. poeticus* and *N. tazetta* and is probably a naturally occurring hybrid that originated in southern France (Webb 1980). *Narcissus biflorus* Curt. is a frequently encountered synonym for this taxon. *Narcissus* x *medioluteus* commonly is planted and frequently encountered in the Arkansas flora outside of cultivation. It is an extremely vigorous grower and reproduces asexually via bulblets. One of the characteristics that helps distinguish *N.* x *medioluteus* from other *Narcissus*

taxa is the bright yellow coloration found at the base of the perianth segments; note that some forms of *N. poeticus* and *N. tazetta* also may have similar coloration on the perianth segments. *Narcissus* x *medioluteus* is the latest flowering *Narcissus* in Arkansas. Disturbed woods, woodland edges, hillsides, pastures, fields, roadsides, and old home sites. Flowering March–May.

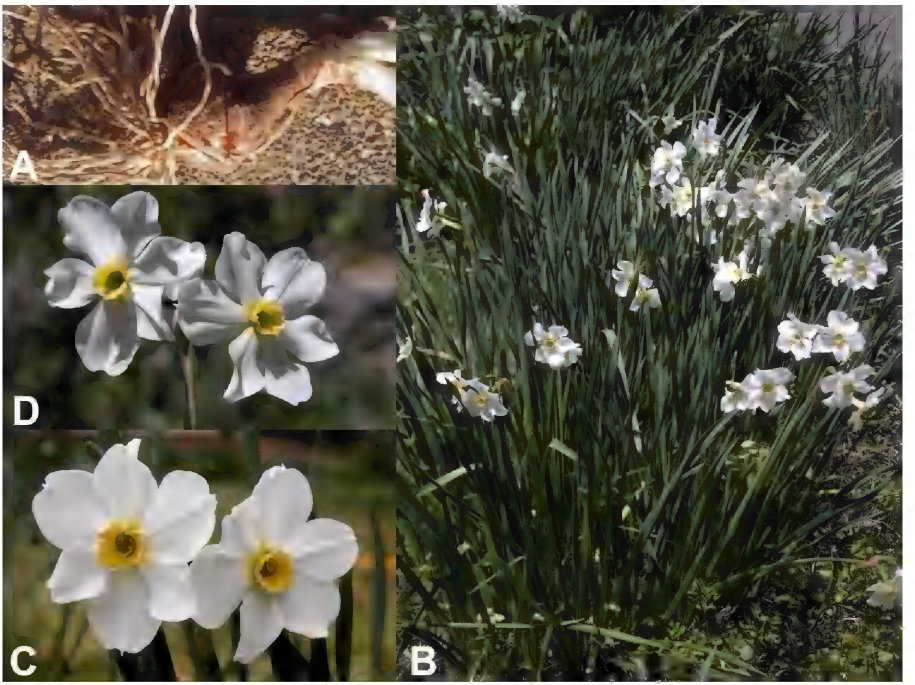
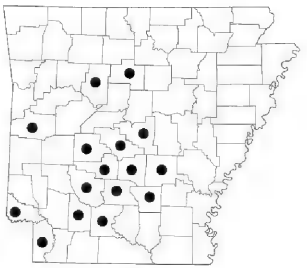


Figure 16. *Narcissus x medioluteus.* (A) Bulb and roots. (B) Plants. (C–D) Flowers and inflorescences.

Narcissus x odorus L. – CAMPERNELLE JONQUIL; SWEET-SCENTED JONQUIL (Fig. 17)



Narcissus x *odorus* is a sterile, intersectional hybrid between *N. jonquilla* and *N. pseudonarcissus*; it is probably of garden origin (Webb 1980). It has become naturalized in both Europe (where the parental species are native) and the USA, including Arkansas. This taxon is one of the most frequently cultivated *Narcissus* in the state and also one of the most commonly encountered outside of cultivation. Vegetatively, *N.* x *odorus* closely resembles *N. jonquilla*, *N.* x *intermedius*, and *Narcissus* sp.; however, it may reliably be distinguished from them by its flowers with narrowly elliptic to ovate–elliptic, widely–spaced perianth segments. In contrast, all three of the vegetatively similar taxa have overlapping to nearly overlapping perianth segments that are broadly ovate, obovate, or subrotund. The flowers of *N.* x *odorus* also are larger than those of *N. jonquilla* and *N.* x *intermedius*. *Narcissus* x *odorus* is a hardy and vigorous plant that increases its numbers through asexual production of bulblets. Woodland edges, hillsides, pastures, fields, roadsides, ditches, and old home sites. Flowering February–April.

Figure 17. *Narcissus* x *odorus*. (A & E) Flowers and inflorescences. (B) Plants. (C) Flower with missing perianth segments; it is occasional in *N. X odorus* to have flowers with 3, 4, or 5 perianth segments instead of the 6 that are typical. (D) Bulb and roots.

Narcissus papyraceus Ker–Gawl. — PAPER–WHITE NARCISSUS (Figs. 18–19)

Narcissus papyraceus is native to the Mediterranean region and southern Europe (Webb 1980). It is occasionally cultivated in Arkansas and long–persistent, with cultivated plants having been observed increasing vegetatively via bulblets. *Narcissus papyraceus* has been documented as naturalized from a number of other states, including Alabama, California, Louisiana, and Texas (Thomas & Allen 1993; Nesom 2010; USDA, NRCS 2016), but until 2016 it had not been documented from the Arkansas flora. *Narcissus papyraceus* has sometimes been considered conspecific with the morphologically similar *N. tazetta*; being treated as only a variety of it [*N. tazetta* var. *papyraceus* (Ker–Gawl.) Baker]. The two species are morphologically similar and intergrade in most characteristics (Webb 1980). Fresh material of *N. papyraceus* and *N. tazetta* may, however, generally be distinguished by differences in flower color—the corona and perianth segments of *N. papyraceus* flowers are typically concolorous and white, whereas the corona of *N. tazetta* flowers is yellow or orange and generally clearly darker in color than the perianth segments. The color differences of the flowers often become obscured on dried material, and the two species are difficult to differentiate among herbarium specimens; hence, positive identification is best

accomplished using fresh material (Straley & Utech 2002). It also is important to note that some forms of *N. papyraceus* have cream to off–white–colored coronas that are darker in color than the perianth segments (Blanchard 1990; Howard 2001). The distinction between *N. tazetta* and *N. papyraceus* may be further confounded in that certain "*tazetta*" cultivars, such as 'Grand Primo', 'White Pearl', and 'Polly's Pearl', among others, are apparently interspecific hybrids of garden origin between *N. tazetta* and *N. papyraceus* that have pale yellow, cream, or off–white coronas that sometimes fade to white as they age (Howard 2001). These plants closely resemble *N. papyraceus* in growth form and flower color, particularly as the flowers age. The Miller County plants of *N. papyraceus* have young flowers with off–white to pale cream coronas that fade to white as they age (Fig. 19). It is not inconceivable that these *N. papyraceus* plants may, in fact, be one of the aforementioned hybrid *tazetta* cultivars. Regardless, they were spontaneous along a roadside with no apparent evidence of prior cultivation present at the site. *Narcissus papyraceous* is the earliest flowering species of *Narcissus* in Arkansas, sometimes flowering in late autumn; the flowers are strongly sweet–fragrant. Roadsides, fields, lawns, and other disturbed areas. Flowering November–March.

Voucher specimen. **Arkansas**. Miller Co.: County Road (CR) 118, 0.1 mi N of the intersection of CR 118 and US Hwy 82, open field on W side of road, sandy soils, 6 widely separated plants, 28 Feb 2016, *Keesling 16–0007* (ANHC).

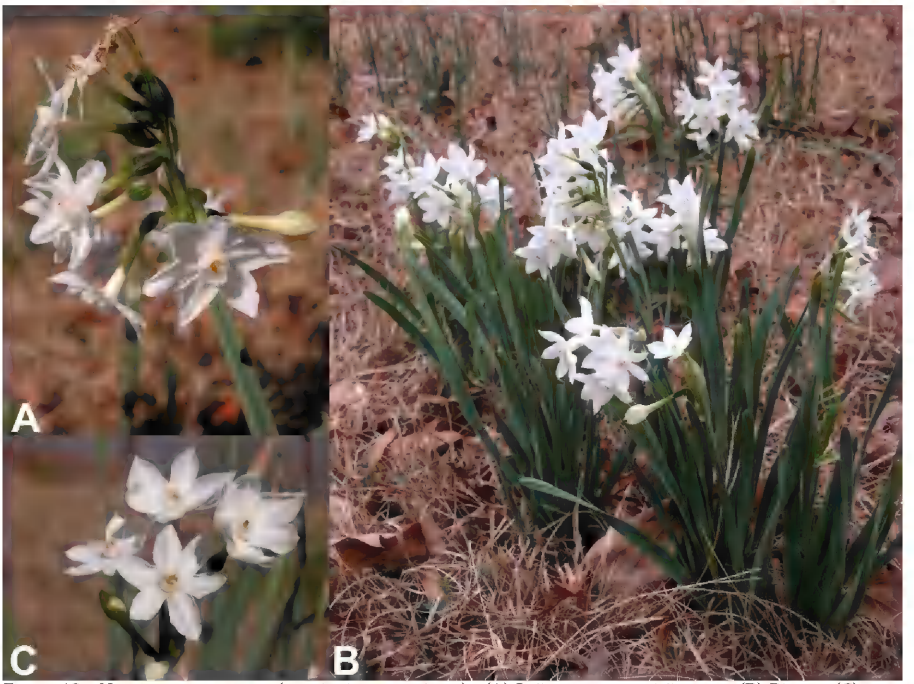
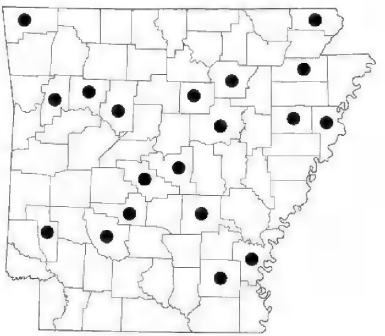


Figure 18. *Narcissus papyraceus* (standard paper–whites). (A) Inflorescence and flowers. (B) Plants. (C) Close–up of flowers.

Figure 19. *Narcissus papyraceus*. (A) Naturalized plants in Miller County, Arkansas. (B) Plants with young and older flowers; some of the younger flowers with off–white to pale cream–colored coronas are indicated by the yellow arrows (photo credit Jim Keesling).

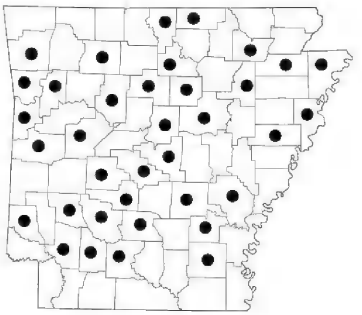
Narcissus poeticus L. – PHEASANT'S EYE; POET'S NARCISSUS (Fig. 20)



Narcissus poeticus is native to open areas of southern Europe (Webb 1980). It is sometimes cultivated and naturalized in Arkansas. It is the only *Narcissus* species found in Arkansas with a red margin on the corona. Although the perianth segments are usually white, young flowers sometimes have cream to creamy–yellow coloration on the perianth. *Narcissus poeticus* is somewhat similar to, and could potentially be confused with, *N.* x *medioluteus*; however, it may easily be distinguished from *N.* x *medioluteus* by its solitary flowers and corona with a red–colored margin. In contrast, *N.* x *medioluteus* has most inflorescences with two flowers and the margin of the corona is yellow, not red. Fields, roadsides, and old home sites. Flowering March–April.

Figure 20. *Narcissus poeticus.* (A & D) Flowers (notice the creamy–yellow coloration on the base of the perianth segments of the flower in Fig. D). (B) Plants. (C) Bulb and roots.

Narcissus pseudonarcissus L. – TRUMPET NARCISSUS; DAFFODIL (Figs. 21–22)



Narcissus pseudonarcissus is a highly variable species that is native to much of Europe, and is commonly cultivated and has naturalized much beyond its native range in Europe (Webb 1980). It also is frequently cultivated and naturalized in the USA, including Arkansas, and is the most commonly encountered species of *Narcissus* in the state. It probably naturalizes (in Arkansas) from a combination of seed production and vegetative reproduction via bulblets. Arkansas plants of *N. pseudonarcissus* sometimes produce seeds (Fig. 22A). *Narcissus pseudonarcissus* may be distinguished from all other Arkansas *Narcissus* by its corona, which is as long or longer than the perianth segments. Other *Narcissus* species encountered in the state's flora have a corona that is clearly shorter in length than the perianth segments. Disturbed woods, woodland edges, hillsides, pastures, fields, roadsides, lawns, and old home sites. Flowering January–March. Fruiting March–June.

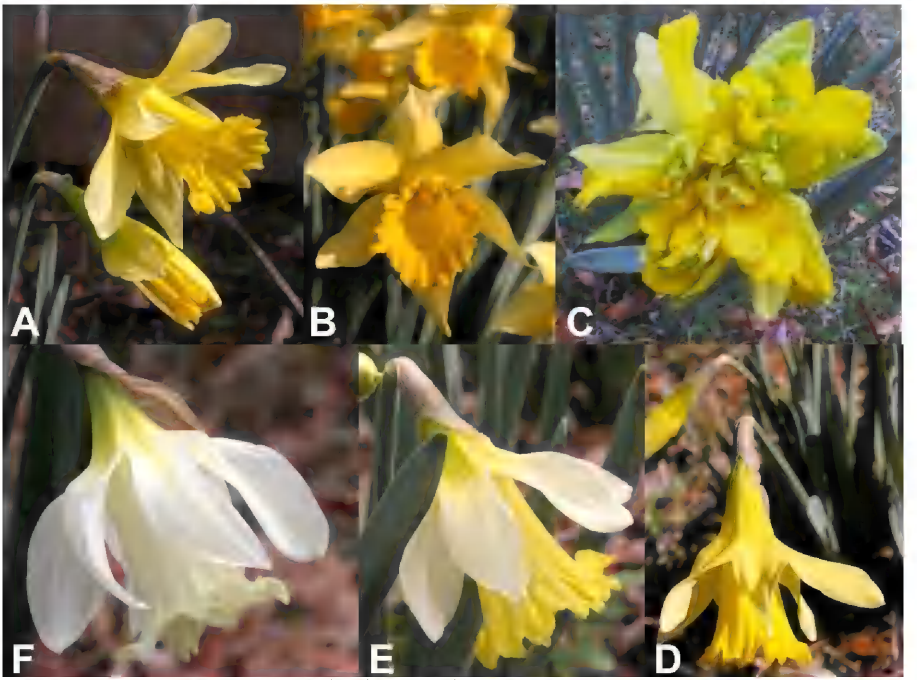


Figure 21. *Narcissus pseudonarcissus*. (A–F) Flowers (Fig. C shows a "doubled" form, where the perianth segments are dissected and some to all of the stamens have been converted to petals; Fig. F shows a white–flowered form, possibly *N. pseudonarcissus* L. subsp. *moschatus* (L.) Baker (sometimes considered a distinct species, *N. moschatus* L.) that is occasionally encountered in Arkansas; Figs. A and D show the wild–type flower form).

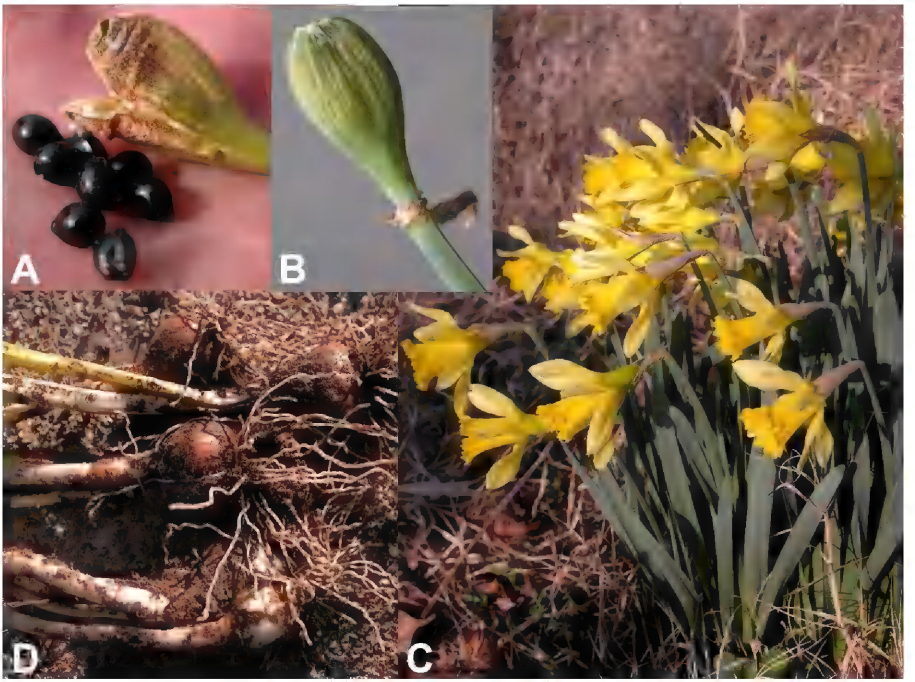
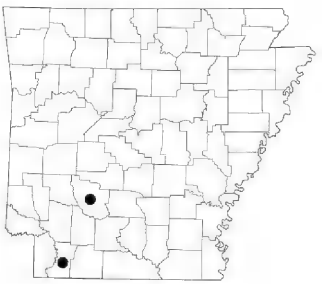


Figure 22. *Narcissus pseudonarcissus*. (A) Mature fruit and seeds (from Arkansas plants of *N. pseudonarcissus*). (B) Nearly mature fruit. (C) Plants. (D) Bulbs and roots.

Narcissus tazetta L. – POLYANTHUS NARCISSUS; BUNCH–FLOWER DAFFODIL (Figs. 23–24)



Narcissus tazetta is a robust species with strongly fragrant flowers that is native to open areas of southern Europe, Asia, and North Africa (Webb 1980; Ji & Meerow 2000). It is rare in the Arkansas flora outside of cultivation. *Narcissus tazetta* is a highly polymorphic species, showing tremendous variation with regard to flower size and color, number of flowers per inflorescence, and leaf width. For example, perianth segments may range in color from white or cream to yellow, and the corona from pale to dark yellow or orange. The width and degree of overlap of the perianth segments also is variable. This high degree of morphological variation is at least in part because of artificial selection, as *N. tazetta* has been cultivated for centuries (Webb 1980). According to Blanchard (1990), the typical *N. tazetta* has flowers with white perianth segments and a dark yellow corona. Morphologically, *Narcissus tazetta* closely resembles *N. papyraceus*; however, it generally may be distinguished from *N. papyraceus* by its yellow to orange coronas that are clearly darker in color than the perianth segments (most *N. papyraceus* have the perianth and corona concolorous and pure white in color). Fresh specimens should be examined if corona color is used to distinguish the two species, as dried specimens are often difficult to distinguish (Straley & Utech

2002). The Clark County records of *N. tazetta* may be examples of some of the "*tazetta*" cultivars, such as 'Grand Primo' and 'Early White', which are, in fact, apparently interspecific hybrids of garden origin between *N. tazetta* and *N. papyraceus* (Howard 2001; see discussion under *N. papyraceus* for additional information). Fields, roadsides, and old home sites. Flowering February–April.

Voucher specimens. **Arkansas**. Clark Co.: Arkadelphia, Henderson State University campus, E side of parking area behind old Caddo building, a few clumps of plants growing on a disturbed, semi–unkempt hillside, probably long–persistent from cultivation but not planted recently, several clumps of *Lycorus radiata* also present, 17 Feb 2009, *Serviss 7399* (HEND); Arkadelphia, North 19th Street, old home site, E side of property, probably persistent from cultivation, 12 Mar 2007, *Worth 37* (HEND).

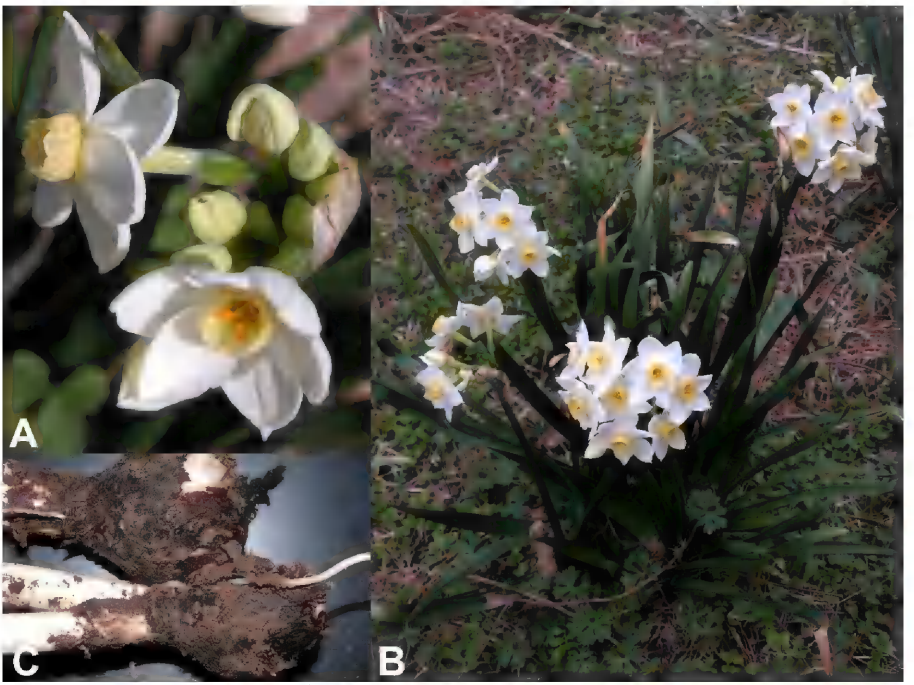


Figure 23. *Narcissus tazetta* cultivar (the plant shown here is probably one of the hybrid *tazetta* cultivars, such as 'Grand Monarque' or 'Grand Primo'; some of these *tazetta* hybrids are large, robust plants that can be long–persistent subsequent to cultivation practices). (A) Flowers. (B) Plant and inflorescences. (C) Bulbs.

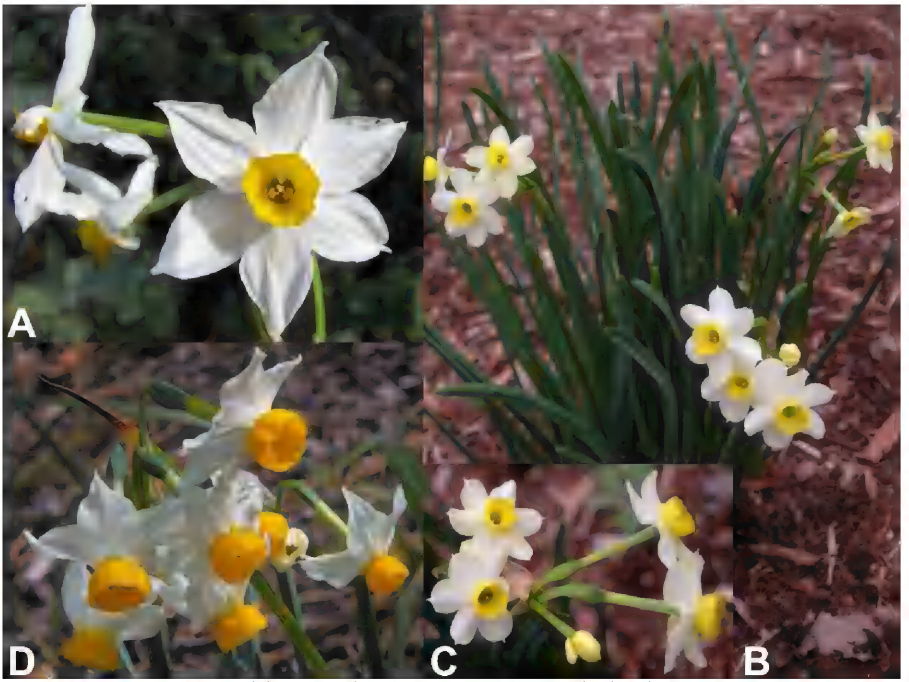
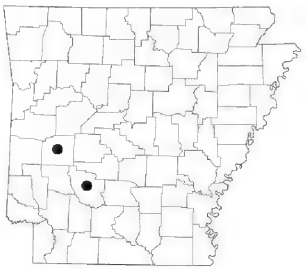


Figure 24. *Narcissus tazetta*. (A) Flowers (photo credit Nhu H. Nguyen). (B–C) Flowers and plants of an *N. tazetta* cultivar (the flowers of this cultivar are reminiscent of those of wild-type *N. tazetta* plants; however, wild forms of *N. tazetta* often have coronas that are darker yellow and perianth segments that are folded/curved inward at the margins, as shown in Figs. A & D). (D) Flowers and inflorescence—notice the dark yellow–orange coronas and yellow coloration at the base of the perianth segments (photo credit Mary Sue Ittner).

Narcissus x tenuior Curt. – SLENDER NARCISSUS (Fig. 25)



Narcissus x *tenuior* is a sterile hybrid, presumably between *N. jonquilla* and *N. poeticus* that is probably of garden origin (Meyer 1966). *Narcissus* x *gracilis* Sab. is sometimes considered to be a similar, yet distinct, species from *N.* x *tenuior*. Meyer (1966) states that *N.* x *gracilis* is probably only a form of *N.* x *tenuior*, and should be considered synonymous with it; however, Blanchard (1990) made a distinction between the two taxa based on the smaller overall plant size, less robust habit, and fading of the perianth segments from yellow to nearly white or white as distinctly characteristic of *N.* x *tenuior*. *Narcissus* x *tenuior* is rarely encountered persistent from cultivation and probably only sparingly naturalized in Arkansas. *Narcissus* x *tenuior* is morphologically somewhat similar to a few other *Narcissus* taxa more commonly encountered in the state, including *N.* x *medioluteus* and certain forms of *N. tazetta*. The flowers of *N.* x *tenuior* are unusual in that the perianth typically fades from yellow to almost white or white as the flowers age, resembling a diminutive form of *N.* x *medioluteus* at that stage. The leaves of *N.* x *tenuior* are linear and grass-like. *Narcissus* x *tenuior* has not been previously recorded from Arkansas. Fields, roadsides, and old home sites. Flowering March-April.

Voucher specimens. **Arkansas**. Clark Co.: Arkadelphia, N 34º 09.033 W 093º 03.8081, open field with scattered trees, single clump of plants, *Allium canadense* also present at site, 3 Apr 2002, *Slaughter 2* (HEND). Montgomery Co.: Hwy 270, about 1 mi W of Pencil Bluff, old home site and adjacent bluff and roadside, numerous plants, appeared to be well–naturalized, 5 Apr 2003, *Serviss 5128* (HEND).

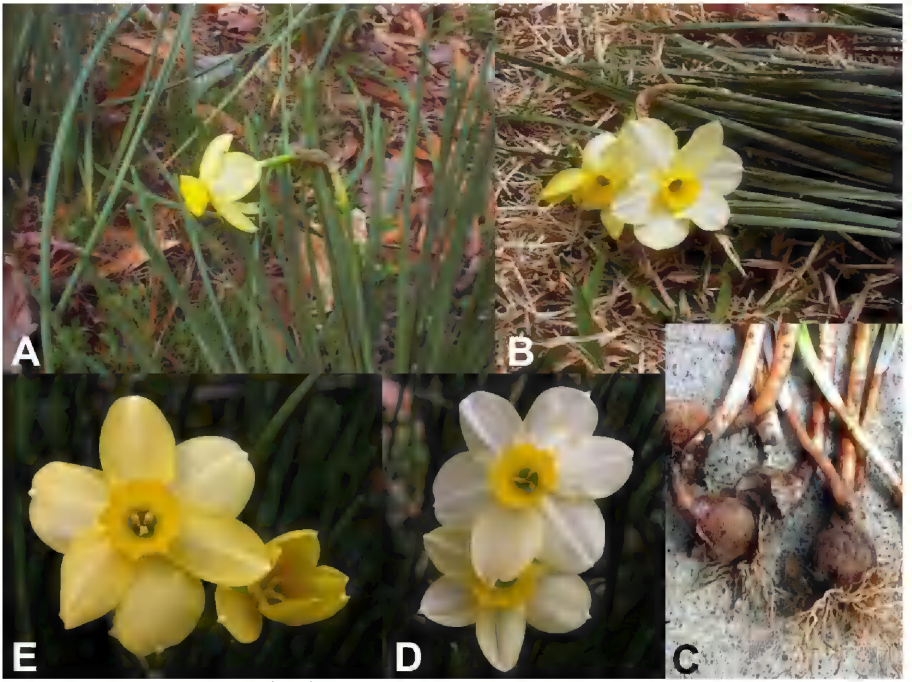


Figure 25. *Narcissus* x *tenuior*. (A–B) Flowers and leaves; the reflexed perianth segments shown in Fig. A are not atypical. (C) Bulbs and roots. (D–E) Flowers (the flowers in Fig. E are new, whereas those in Fig. D are older; notice how the perianth segments have faded from yellow to yellowish–white).

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We would like to sincerely thank all of the students that have invested many hours of field time assisting with the collection of *Narcissus* specimens: Mr. Todd Bunch, Mr. Brian Caldwell, Ms. Karen Kolb–Spencer, Mr. Allen Leible, Mr. Justin Mitchell, Mr. Norman Montgomery, Mr. Adam Rivers, Mr. Dean Slaughter, Ms. Megan Stone, Ms. Laura Stroope, and Mr. Jason Wilis. We also very sincerely thank Dr. James H. Peck for contributing a number of specimens of naturalized *Narcissus*, along with Dr. Jane Dunn, Mr. Jason Haley, Mrs. Tricia Serviss, Dr. George Ann Stallings, and Mrs. Beth Worth for collection of *Narcissus* specimens, many of which were beyond the borders of southwestern Arkansas. We thank Mr. Steve Vinisky for assistance with cultivar designations. We also thank the ANHC, LRU, and UARK herbaria and their curators for making specimens available for study. As always, we are grateful to the Henderson State University and University of Arkansas at Little Rock Biology Departments for supporting this work.

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NEW DISTRIBUTION RECORDS FOR ACANTHACEAE IN MEXICO

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ABSTRACT

Geographic range extensions are documented and discussed for 30 species in 18 genera of Acanthaceae that occur in Mexico. Most of these are new state records; one (*Mendoncia lindavii*) is also reported as new to the country; four are significant range extensions within a state. Images of 19 of these species are provided.

RESUMEN

Ampliaciones de distribución geográfica se documentan y analizan para 30 especies en 18 géneros de Acanthaceae que ocurren en México. La mayoría de estos son nuevos registros estatales; uno (*Mendoncia lindavii*) también es reportado como nuevo en el país; y cuatro son extensiones importantes dentro de un estado. Se proporcionan las imágenes de 19 de estas especies.

Extensions of distributional ranges within Mexico are reported for 30 species in 18 genera of Acanthaceae, including both native and naturalized species. Initial occurrences for 26 species in one or more Mexican states are reported for the first time. One of these occurrences (*Mendoncia lindavii* in Chiapas) is also the first report of this species in Mexico. New distribution records are noted for the following states (numbers of species): Aguascalientes (5), Campeche (1), Chiapas (1), Durango (1), Guerrero (2), Hidalgo (4), México (1), Morelos (1), Nayarit (1), Oaxaca (2), Puebla (4), Tabasco (1), Tamaulipas (2), Tlaxcala (1), Veracruz (2), Zacatecas (1). In addition to the new distributional records for states, significant range extensions within a state are noted for four mostly rare, little-known, and/or geographically restricted species.

Documented knowledge of occurrence data for plants in Mexican states has become increasingly important for efforts to provide accurate biodiversity inventories for each state in that nation. New occurrence records of Acanthaceae noted here have resulted primarily from recent collecting activities in several states and my continuing studies in the many excellent local herbaria in Mexico. The value of focused collecting efforts in poorly explored regions was recently highlighted by inventory activities in the states of Baja California and Aguascalientes, resulting in range extensions for several taxa in each. Daniel (1997, 2013) recorded five species of Acanthaceae from Baja California, and a sixth species, *Avicennia germinans* (L.) L., also known from the state, is now treated in that family as well. Wehncke et al. (2012) and León de la Luz et al. (2016) added three species of Acanthaceae from explorations in the poorly explored Sierra de la Libertad region to flora of Baja California: *Dicliptera resupinata* (Vahl) Juss., *Justicia longii* Hilsenb., and *Tetramerium fruticosum* Brandegee. This increased the known acanthaceous flora of that state by one-third. For Aguascalientes, Daniel (2013) recorded six species of Acanthaceae as occurring in that small state in central Mexico. Regalado G. et al. (1999) had recognized 14 species from the state in a publication unknown to me until 2014. Studies at HUAA in Aguascalientes permitted me to reassess many of the determinations in Regalado G. et al. (1999) and to add new records. As a result, 18 species, including several newly reported below, are now known from that state.

In this account of distribution records in Mexico, the Distrito Federal (DF) is treated as a state. For species not recently treated by me in a publication, the most recent state-wide (or major regional) summary of Acanthaceae, if available, was used as a reference against which potential new

records were compared. These major reference(s) by state are: Aguascalientes (García et al. 1999); Campeche (Durán et al. 2000; Gutiérrez B. 2000; Martínez et al. 2001), Chiapas (Daniel 1995), Durango (González E. et al. 1991), Guerrero (Fernández et al. 1998), Michoacán (Rodríguez J. and Espinosa G. 1995; Fernández et al. 1998), Morelos (Bonilla B. and Villaseñor R. 2003), Oaxaca

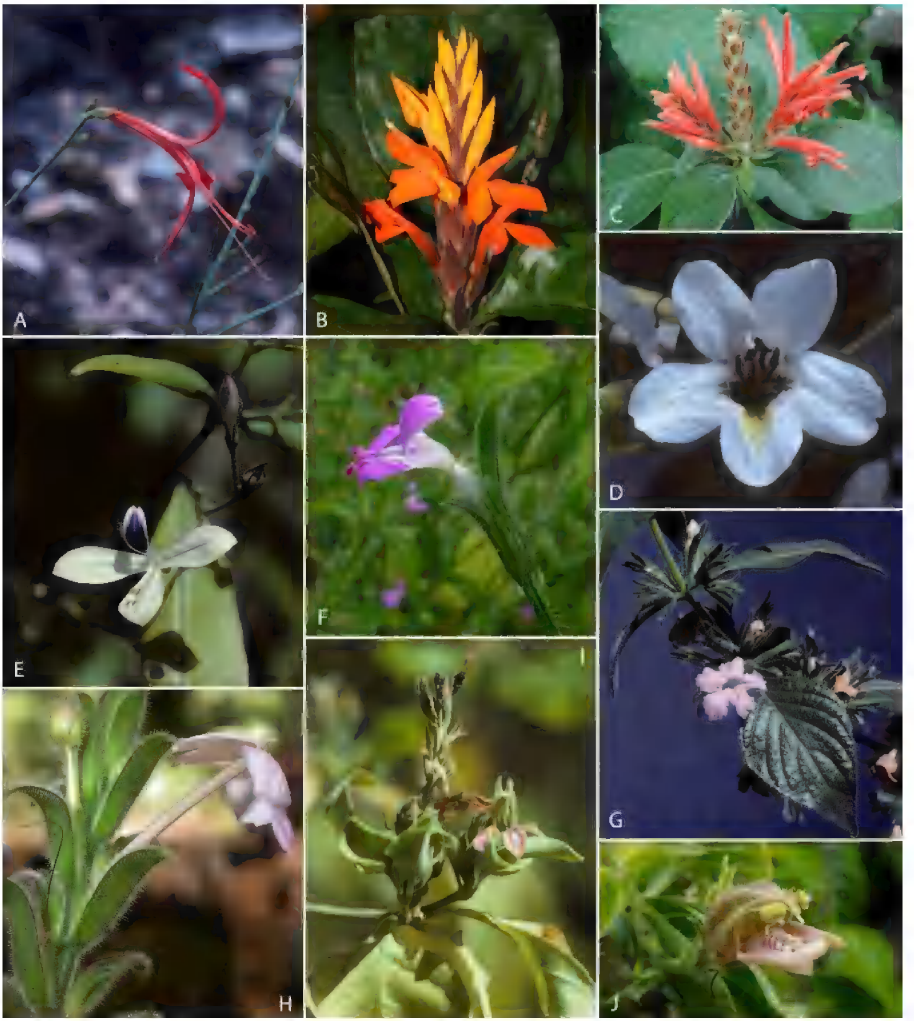

Figure 1. Photographs (by the author, except as noted) of flowers and inflorescences of Mexican Acanthaceae. A. *Anisacanthus junceus*. B. *Aphelandra aurantiaca*. C. *Aphelandra scabra*. D. *Bravaisia integerrima*. E. *Carlowrightia pectinata*. F. *Dicliptera peduncularis*. G. *Dyschoriste hirsutissima*. H. *Streblacanthus monospermus* (Daniel Solano photo; Instituto Nacional de Biodiversidad, Costa Rica, Creative Commons 3.0 License, http://atta2.inbio.ac.cr/neoportal-web#). I. Hol*ographis leticiana*. J. *Justicia salviiflora*.

Figure 2. Photographs (by the author, except as noted) of flowers and inflorescences of Mexican Acanthaceae. A. *Justicia veracruzana* (photo by J. Amith, used with permission). B. *Louteridium mexicanum*. C. *Mendoncia lindavii*. D. *Pseuderanthemum cuspidatum*. E. *Ruellia ciliatiflora*. F. *Ruellia simplex*. G. *Sanchezia parvibracteata*. H. *Thunbergia fragrans*. I. *Tetramerium nemorum*.

(Acosta C. 2011), Puebla (Rodríguez A. et al. 2014), Tabasco (Cowan 1983; Pérez et al. 2005), and Veracruz (Sosa and Gómez-Pompa 1994). In addition to these studies, numerous local floras and my unpublished list of acanthaceous species for each state in Mexico were also consulted. A comprehensive taxonomic account of the ca. 400 species of Acanthaceae in Mexico is nearing completion. Until completed and published, new distribution records like those below, will be made available so that up-to-date occurrence data is accessible for statewide biodiversity inventories being prepared in Mexico. The following distribution records provide collection information, geographic ranges, and pertinent taxonomic notes.

ANISACANTHUS JUNCEUS (Torr.) Hemsl.

Durango: KM 151 carr. Cuencame–Gómez Palacio, veg. matorral xerófilo, 25 X 2004 (flr, frt*), R. Torres C. 16727B* (MEXU).

This collection is the first report of the species (Fig. 1A), endemic to the Chihuahuan Desert in Mexico, from Durango; it is otherwise known only from Chihuahua, Coahuila, and Zacatecas (Daniel & Henrickson 1982).

ANISACANTHUS PUMILUS (Dietr.) Nees

Aguascalientes: Mpio. Calvillo, extremo W de La Labor, matorral subtropical, 1750 m, 10 IV 1986 (flr), *G. García R. 2632* (HUAA); Mpio. Jesús María, Arroyo La Pachona, 3 km W del Garabato, 22°05'16" N, 102°21.4'41" W, matorral subinerme con nopalera, 1990 m, *G. Glez.-Adame 1277* (HUAA); Mpio. Asientos, Río San Gil, matorral subinerme, 1740 m, 11 IV 1984, *M. Siqueiros 2633* (HUAA).

Hidalgo: 7 km W de Tlahualipa (Cerro Xicuco), ladera de roca cristalina con vegetación de matorral crasicaule, 1900 m, 22 IV 1965 (flr, frt), *L. González Q. 2292* (DS).

The collections cited above are the initial reports for this species from Aguascalientes (occurring throughout the state) and Hidalgo (occurring in the north-central portion of the state). This Mexican endemic was previously known from Chihuahua, Guanajuato, Jalisco, Michoacán, Puebla, Querétaro, San Luis Potosí, and Zacatecas (Daniel & Acosta C. 2003).

APHELANDRA AURANTIACA (Scheidw.) Lindl.

Puebla: Mpio. San Juan Guichicobi, Ejido Mogone (9 km E de Sarabia), selva alta perennifolia, 07-XII-1974 (flr), *M. Vazquez T. 1462* (XAL).

This is the first report of this species for the state. *Aphelandra aurantiaca* (Fig. 1B) has been reported from the Mexican states of Chiapas, Oaxaca, Tabasco, and Veracruz (Daniel 1991). The species also occurs in Central America and South America.

APHELANDRA SCABRA (Vahl) Sm.

Puebla: Mpio. San Sebastián Tlacotepec, Río Matalapa–Puente de Tepetla, 18°26'46.1" N, 096°48'00.8" W, 123 m, vegetación riparia, 3-XII-2014 (flr), *L. Caamaño O. 6638* (HUAP-image!).

This is the first report of *Aphelandra scabra* (Fig. 1C) from Puebla. This widespread species of the American tropics has been reported previously from the following Mexican states: Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Tamaulipas, Veracruz, and Yucatán (Daniel 1995). Outside of Mexico, the species occurs in all of the nations in Central America and in Colombia, Venezuela, Guyana, Suriname, and Brazil.

AVICENNIA BICOLOR Standl.

Chiapas: Mpio. Pijijiápan, Estero San José, 15°43'39.50" N, 093°29'50.20" W, 11 m, manglar con *A. germinans*, *Laguncularia racemosa,*, 14 IV 2015 (flr), *S. Santamaría-Damián & E. Romero-Berny 1a* (MEXU), *1b* (MEXU).

This appears to be the second known collection of this species in Mexico. *Matuda 16353* (US), from a coastal region ca. 55 km northwest of the locale noted above first established the presence of this species in Mexico, although its occurrence in Chiapas sometimes has not been recognized (e.g., Breedlove 1986). These Chiapan collections represent the northernmost extent of the occurrence of the species, and are located about 430 km northwest of the nearest known locale in Central America (Ahuachapán, El Salvador). The species has not been reported from Guatemala, but

it undoubtedly occurs (or occurred) there (Daniel 2010). Outside of Mexico, *A. bicolor* occurs along the Pacific Coast from El Salvador to Panama.

BRAVAISIA INTEGERRIMA (Spreng.) Standl.

Nayarit: Mpio. Bahía de Banderas, Club de Golf Flamingos, cerca de Bucerias, [ca. 20°44'13.02" N, 105°18'21.46" W], 10 m, manglar, 18-III-2005 (flr), *M. Chazaro B. & R. Romero 8476* (XAL).

This report is the first of this predominantly coastal species in Nayarit, which represents its northernmost occurrence. Elsewhere in Mexico, *Bravaisia integerrima* (Fig. 1D) is known from Chiapas, Coloma, Guerrero, Jalisco, Michoacán, Oaxaca, Tabasco, Veracruz, and possibly Yucatan (Daniel 1988a). South of Mexico, the species is known from Central America, northern South America, and Trinidad.

CARLOWRIGHTIA PECTINATA Brandegee

Guerrero: Mpio. Olinala, 4 km N de Sta. Gertrudis, por el camino Olinala–Paplutla, 1300 m, bosque tropical caducifolio, 18 XI 1985 (flr, frt), *J. Contreras J. 1798* (HUAP-image!); Mpio. Atenango del Río, 2.73 km NW de Apanguito, 18°10'26.9" N, 099°09'44.7" W, 930 m, bosque tropical caducifolio, 23 XI 2003 (flr, frt), *R. Cruz & R. Garcia 5863* (FCME).

These collections represent the first report of *Carlowrightia pectinata* (Fig. 1E) from Guerrero. This Mexican endemic previously has been reported from the following states: Baja California Sur, Colima, Durango, México, Morelos, Oaxaca, Sinaloa, and Sonora (Daniel 1983, 1988b, 2005a, 2007). Daniel (1988b, 1997, 2004) noted various color forms of corollas in this species. Corollas of *Cruz & Garcia 5863* are 12 mm long and were noted to be white with dark purple markings on the upper lip; those of *Contreras J. 1798* were noted to be white.

DICLIPTERA PEDUNCULARIS Nees

Veracruz: Mpio. Maltrata, alrededores de Maltrata, 18°49' N, 097°17' W, 1700 m, pastizal, 8-IV-1983 (flr), *F. Vázquez B. 861* (XAL).

This is the first report of this, sometimes weedy, Mexican endemic (Fig. 1F) from Veracruz. It has previously been reported to occur in the following Mexican states: Aguascalientes, Distrito Federal, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Michoacán, Oaxaca, Puebla, Querétaro, and San Luis Potosí (Daniel 2009; Daniel & Acosta C. 2003; Valencia A. et al. 2011).

DYSCHORISTE HIRSUTISSIMA (Nees) Kuntze

Aguascalientes: Mpio. Calvillo, barranca de Presa de Los Serna, 21°49'13.3" N, 102°49'03.3" W, *G. García 5396* (HUAA); Mpio. Calvillo, Río Malpaso, *M. Siqueiros 2744* (HUAA).

These collections are the initial records of this species in Aguascalientes. *Dyschoriste hirsutissima* (Fig. 1G) is known from El Salvador and the following Mexican states: Chiapas, Chihuahua, Colima, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Sinaloa, Sonora, Veracruz, and Zacatecas (Daniel 2007).

DYSCHORISTE MICROPHYLLA (Cav.) Kuntze

Aguascalientes: Mpio. San Jose de Gracia, Reserva "Sierra Fria,"28.6 km N por carr. 45 de Aguascalientes, 10.8 km de la desviación hacia San Jose de Gracia entronque a Congoje, 24.1 km hacia Congoja en terraceria, 2350 m, 5 VII 1983 (flr, frt), *C. Cowan 4026* (MEXU); Mpio. Jesús María, 26.7 km W de Aguascalientes, carr. a Calvillo, matorral xerófilo con *Quercus*, 13 Jun 1984 (flr), *H. Hernández et al. 239* (MEXU); Mpio. Calvillo, southern Sierra Fria, ca. 2 km W of La

Fragua, ca. 21°46.1' N, 102°48.5' W, 1700 m, tropical deciduous forest, 31 VII 2002 (flr, frt), *M. Provance 5144* (CAS).

Tlaxcala: Mpio. Calpulalpan, carr. Texcoco–Apizaco, 15 km antes de Calpulalpan, 19°33'53.2" N, 098°40'19.6" W, 2770 m, orilla de campo, escasa, 6 VI 2001 (flr, frt), *H. Vibrans 7260* (MEXU).

These are the first reports of this Mexican endemic from Aguascalientes and Tlaxcala. The species was previously known from the following Mexican states: Guanajuato, Hidalgo, México, Michoacán, Oaxaca, Puebla, Querétaro, and Zacatecas (Daniel & Acosta 2003). With its denser cauline and foliar trichomes, *Cowan 4026* from Aguascalientes could with some justification be treated as *D. decumbens*. The distinctions between *D. decumbens* of northern Mexico and the southwestern United States and *D. microphylla* are in need of additional studies (cf. Daniel & Acosta 2003: 40–41). The identifications here are based on the key and information provided in the treatment of Acanthaceae for the *Flora del Bajío* (Daniel & Acosta 2003).

This represents the second known occurrence of a species of Acanthaceae in Tlaxcala (the other is *Ruellia lactea* Cav.), thus doubling the number of species recorded for that state. Perhaps Tlaxcala's relatively high elevation is one limiting factor preventing more occurrences of Acanthaceae, including such widespread and weedy species as *Elytraria imbricata* (Vahl) Pers., *Ruellia blechum* L., and *Tetramerium nervosum* Nees, which are generally encountered at elevations below 2000 meters. Based on their known occurrences at elevations above 2000 meters in Mexican pine forests, one might expect the following widespread species to be found in the state: *Justicia clinopodium* A. Gray ex Greenm., *J. pringlei* B.L. Rob., *Pseuderanthemum praecox* (Benth.) Leonard, *Ruellia hookeriana* (Nees) Hemsl. and *Stenandrium dulce* (Cav.) Nees.

HOLOGRAPHIS HINTONII (Leonard) T.F. Daniel

Guerrero: Mpio. Huitzuco de los Figueroa, 0.7 km NE de San Francisco Ozomatlán, [17°55'45.67" N, 099°19'20.58"W], 670 m, 30 III 1990 (flr), *A. Vargas P. 287* (FCME).

This represents the second known collection from Guerrero for this little-collected Mexican endemic, and increases its distribution in the state some 140 km to the southeast and its known elevational range to 670 m (from 375 m). The species has also been collected in Michoacán (Daniel 2005a).

HOLOGRAPHIS LETICIANA T.F. Daniel

Oaxaca: Distr. Cuicatlán, Mpio. Cuicatlán, 13 km W de Cuicatlán sobre el antiguo camino a Santiago Quiotepec, 17°51'21" N, 096°58'43" W, 684 m, selva baja caducifolia, 18 XII 2000 (flr), *E. Martínez S. et al. 33337* (MEXU); Distr. Huajuapan de León, Mpio. Zapoquila, Cerro Prieto, al NE de Membrillos, 18°02' N, 097°32' W, 2420 m, 2 XI 2001 (flr), *P. Tenorio L. & L. Kelly 21437* (MEXU).

This Mexican endemic (Fig. 1I) was originally described from the tropical deciduous forests of southeastern Oaxaca in the vicinity of Tehuantepec (Daniel 1988c). It has since been documented from similar forests along that state's southern coast westward as far as 096°10'6.7"W in the Parque Nacional Huatulco (*Nava Z. et al. 750* at MEXU). The collections noted above extend the range of this species ca. 265 km northwestward across the state to the Tehuacán–Cuicatlán Valley in northwestern Oaxaca. These collections describe the color of the corollas as either "lilas" or "rosas," both of which terms have been applied to collections of *H. leticiana* from southeastern Oaxaca.

JUSTICIA KANAL T.F. Daniel

Tabasco: Parque Nacional de Agua Blanca, Macuspana, KM 64 carr. Villahermosa-Escárcega, 17°38' N, 092°30' W, 100–200 m, selva mediana-alta perennifolia de *Brosimum alicastrum* & *Dalium guianense*, 18 III 1988 (flr*), L. Ruiz P. et al. 8429* (=*Calderón 24*) (HUAA).

This is the first record for the occurrence of this species in Tabasco. It was previously known from the Mexican states of Chiapas and Veracruz, and it also occurs in Guatemala (Daniel 1995). The specimen cited above was previously identified as *J. aurea*, but it has the purplish corollas and other characters of *J. kanal* (Daniel 1995).

JUSTICIA SALVIIFLORA Kunth

Tamaulipas: Mpio. Ocampo, Ejido El Refugio [23°00'00" N, 099°20'58" W] en la Reserva de la Biosfera El Cielo, bosque mesófilo de montaña, 3 III 1993 (flr, frt), *J. Mora L. et al. 268* (XAL).

This is the first report of this Mexican endemic (Fig. 1J) in Tamaulipas, and a range extension of ca. 440 km northeast of its nearest occurrence in Zacatecas. The species has been previously reported from Chiapas, Chihuahua, Colima, Durango, Guerrero, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa, Sonora, and Zacatecas (Daniel 2007).

JUSTICIA VERACRUZANA T.F. Daniel

Hidalgo: Mpio. Tianguistengo, 5 km W de Tianguistengo, 1800 m, bosque perturbado de *Liquidambar*, pino, encino, 25 III 1981 (flr), *R. Hernández M. & D. Rodriguez B. 5616* (MEXU); Mpio. Tenango de Doria, camino de Tenango de Doria a El Cirio (peñascos), arroyo 4 km E de Tenango por camino, 1650 m, bosque mesófilo de montaña, 9 Nov 1985 (fl), *D. Lorence & R. Hernández M. 4912* (CAS); cerca de Tenango de Doria, encinar, 16 IX 1945 (flr), *F. Miranda 3724* (MEXU).

These collections represent the first reports of *Justicia veracruzana* in Hidalgo. Previously known as *Jacobinia paniculata* Oerst., it has been recorded from Puebla and Veracruz (Daniel 2002). Considerable variation was noted among specimens of this species from throughout its range in length of the calyx, color of the corolla, and in pubescence of the inflorescence and corolla. Calyx length varies from 3.8–5 mm (*Lorence & Hernánadez M. 4912*) to 5–18 mm (numerous specimens from Veracruz). Corollas are usually described as red or orangish (sometimes with some yellow coloration as well). Several specimens from Veracruz note yellow corollas. Because corollas of those specimens appear reddish on dried specimens, they are assumed to be red with some yellow coloration associated with the limb, as shown in Figure 2A. Glandular trichomes vary from present to absent on the inflorescence peduncle, rachis, bracteoles, calyx, and corolla.

LEPIDAGATHIS DANIELII R. Cruz D. & J. Jiménez R.

México: Palmar Chico [ca. 18°41'42' N, 100°21'42" W], 20 Jun 1952 (flr, frt), *L. Paray (E. Matuda) 2408* (ENCB).

This species was recently described from the basin of the Río Balsas in Guerrero (Cruz D. & Jiménez R. 2011). The collection noted above extends its range ca. 60 km to the northwest and into the state of México.

Six species of *Lepidagathis* are recognized as occurring in Mexico; these include four species previously treated in *Lophostachys* (Daniel 1993). These two genera are now treated as congeneric by Kameyama (2008), who indicated that the androecium of *Lepidagathis* consists of two or four fertile stamens with the anterior pair bithecous and the posterior pair monothecous, bithecous, or lacking thecae. The androecium of *L. danielii* was described as having the anterior pair of stamens

bithecous and the posterior pair monothecous (Cruz D. & Jiménez R. 2011). Examination of the holotype, three isotypes, and other collections from Guerrero reveal an androecium that is usually as described in the protologue, but that sometimes has two bithecous stamens and two staminodes. The collection noted above from the state of México has four bithecous stamens. Thus, this species exhibits all three androecial conditions noted by Kameyama (2008) for the genus.

LOUTERIDIUM MEXICANUM (Baill.) Standl.

Puebla: Mpio. San Sebastián Tlacotepec, 18°26'12" N, 096°50'31.8" W, cafetal con vegetación secundaria, 427 m, 3-XII-2014 (frt), *L. Caamaño O. 6602* (HUAP-image!).

This is the first report of *Louteridium mexicanum* (Fig. 2B) from Puebla. The species was previously known from the Mexican states of Chiapas, Oaxaca, Tabasco, and Veracruz and the department of Alta Verapaz in Guatemala (Daniel et al. 2012).

MENDONCIA LINDAVII Rusby

Chiapas: Mpio. Ocosingo, Ejido Chajul, [ca. 16°06'44.25" N, 090°55'17.26" W], 150 m, selva mediana subperennifolia, 13 IX 1992 (frt*), E. Martínez S. et al. 25386* (K).

This is the first record of this species in both the state of Chiapas (southeastern Lacandón region) and in Mexico. At this site, ca. 90 km northwest of its closest known occurrence in Guatemala (Cubilgüitz, Alta Verapaz, Guatemala), is the westernmost known occurrence of the species. *Mendoncia lindavii* has previously been documented from Belize, Guatemala, Honduras, Costa Rica, Panama, and South America (Daniel 2005b). *Mendoncia lindavii* (Fig. 2C) can be distinguished from the other two species known from Mexico (*M. guatemalensis* Standl. & Steyerm. and *M. retusa* Turrill) by its red corollas, lance-ovate bracteoles that are three to four times longer than wide, and pubescent drupes with the trichomes eglandular and 0.1–0.8 mm long. Daniel (2005b) provided a key to these three species.

PSEUDERANTHEMUM CUSPIDATUM (Nees) V.M. Baum

Hidalgo: Mpio. Tlanchinol, ca. 6.2 km NE de Tlanchinol, 21°01'40" N, 098°37'51" W, 1309 m, bosque mesófilo de montaña, 21 IX 1997 (frt), *O. Alcántara A. & R. Mayorga S. 3417* (FCME); Mpio. Tlanchinol, 2.5 km N de Tlanchinol, 21°00'40" N, 098°39'07" W, 1475 m, bosque mesófilo de montaña, 20 IX 1997 (frt), *R. Mayorga S. & O. Alcántara A. 897* (FCME).

This is the first report of *Pseuderanthemum cuspidatum* (Fig. 2D) from Hidalgo. *Alcántara A. & Mayorga S. 3417* represents the northernmost known occurrence of the species and an extension of some 240 km NW of its nearest occurrence in central Veracruz. The species has been reported previously from the Mexican states of Chiapas, Oaxaca, Puebla, and Veracruz (Daniel 1995). It also occurs in Central America and South America.

RUELLIA CILIATIFLORA Hook.

Hidalgo: Zimapán, *T. Coulter 1182* (TCD), *1184* (TCD), *1185* (TCD).

This appears to be the first report of this widespread species from Hidalgo. The species (Fig. 2E), usually under the synonym *Ruellia nudiflora* (Engelm. & A. Gray) Urb., has been previously reported from the following Mexican states: Baja California Sur, Campeche, Chiapas, Chihuahua, Coahuila, Colima, Durango, Morelos, Nuevo León, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, and Yucatán (Daniel 2004). Its generalized geographic distribution is from the southern United States southward to Argentina (Daniel 2013a).

RUELLIA HOOKERIANA (Nees) Hemsl.

Aguascalientes: Mpio. Calvillo, intermontane valleys of W Aguascalientes, South Calvillo, along hwy. ca. 1.5 km E of La Mesa Grande turnoff, ca. 21°49.9' N, 102°43.2' W, 1700 m, disturbed areas of tropical scrub along road, 6 VII 1999 (flr), *M. Provance 1239* (UCR).

Puebla: Mpio. Jolalpan, Tecohuetzo, 1.5 km de Zacacuautla, 1370 m, bosque de encino, 31-VIII-1985 (flr), *V. Salas S. & F. Ramos M. 260* (XAL).

Tamaulipas: vicinity of Tampico, 15 m, III-IV (flr, frt), *E. Palmer 215* (K).

These collections represent the first report of *Ruellia hookeriana* from Aguascalientes, Puebla, and Tamaulipas. *Salas S. & Ramos M. 260* from Puebla is somewhat unusual for the species by having the narrow proximal portion of the corolla's tube (22 mm long) slightly shorter than its throat (25 mm long). The species has been reported previously from the following Mexican states: Chiapas, Guanajuato, Guerrero, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Querétaro, San Luis Potosí, Sinaloa, Veracruz, and Zacatecas. It also occurs in Belize, El Salvador, Guatemala, Honduras, and Nicaragua (Daniel 2007).

RUELLIA LACTEA Cav.

Zacatecas: N base of Sierra El Laurel, Rancho La Tarjea, 4.5 km SSE of La Higuera (along Hwy. 70), 21°41.9' N, 102°48.3' W, 1800 m, tropical deciduous forest, 13 VII 1999 (flr), *M. Provance et al. 1446A* (RSA).

This is the first record of this species in Zacatecas. It has been reported previously from Guatemala and the following Mexican states: Aguascalientes, Chiapas, Chihuahua, Distrito Federal, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Oaxaca, Puebla, Querétaro, San Luis Potosí, and Tlaxcala (Daniel & Acosta 2003).

RUELLIA PUBERULA (Leonard) Tharp & F.A. Barkley

Guerrero: Distr. Coyuca, Pungarabato, 11-VII-1934 (flr), *G. Hinton et al. 6275* (K).

This species has apparently not been reported previously from Guerrero. The specimen noted above was annotated by E. C. Leonard as *Ruellia nudiflora* var. *puberula* Leonard but was not cited in his publication of that name (Leonard 1927). It also occurs in Guatemala, El Salvador, and in the Mexican states of Chiapas, Oaxaca, Puebla, and Veracruz (Leonard 1927; Daniel 1995).

RUELLIA SIMPLEX C. Wright

Aguascalientes: Mpio. Calvillo, Cañada Cebolletas, matorral subtropical, 1870 m, 30 VIII 1994, *N. Camarillo C. 36* (HUAA).

This is the first record of the often-cultivated species (Fig. 2F) in Aguascalientes. Because it was noted to occur in thornscrub, this plant might represent a naturalized occurrence because the native distribution of *Ruellia simplex* remains in question. *Camarillo C. 36* pertains to the broader-leaved form of the species (formerly, *R. malacosperma* Greenm.). Possible native or naturalized occurrences of *R. simplex*, including both narrow-leaved (formerly, *R. coerulea* Morong, *R. brittoniana* Leonard, or *R. tweediana* Griseb.) and broader-leaved forms, have been reported from the following Mexican states: Campeche, Chiapas, Guerrero, Hidalgo, Nuevo León, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán (Daniel 1995, 2005a, 2007, 2013b; Daniel & Acosta C. 2003; Durán et al. 2000; Leonard 1936). Outside of Mexico, the species has been reported from the United States (naturalized), Central America, South America, and the West Indies.

RUELLIA SPISSA Leonard

Morelos: Oaxtepec, 1450 m, 23 VII 1971 (flr, frt), *J. Vázquez 3303* (MEXU).

This collection was identified as *Ruellia pilosa* Pav. by Vázquez S. (1974). This likely refers to *R. pilosa* (Nees) Pav. ex Hemsl. (a later homonym of *R. pilosa* L. f.), and its lectotype pertains to *R. hookeriana* (Nees) Hemsl. *Ruellia spissa* has been reported previously from Guatemala and the following Mexican states: Chiapas, Durango, Guanajuato, Jalisco, México, and Michoacán (Daniel & Acosta 2003).

SANCHEZIA PARVIBRACTEATA Sprague & Hutch.

Oaxaca: Distr. Tehuantepec, Mpio. Santa María Guienagati, Puente, sobre terraceria a Peña Blanca, a 2.7 km en LR (160°) de San Isidro Lachiguxe, 16°51'22.2" N, 095°17'23.5" W, 565 m, selva mediana subperennifolia, a orilla de río, con *Alchornea*, 6-II-2007 (flr), *K. Velasco G. et al. 1624* (MEXU, SERO).

Although likely native to South America, the native distribution of this often-cultivated species (Fig. 2G) is not known with certainty (Daniel 1995). *Velasco G. et al. 1624* was not attributed to cultivation and is apparently from a native habitat; thus, it is appears to be the first report for *Sanchezia parvibracteata* being naturalized in Oaxaca. Other occurrences in Mexico from Chiapas and Jalisco were discussed by Daniel (1995, 2013b).

STREBLACANTHUS MONOSPERMUS Kuntze

Veracruz: Mpio. Hueyapan de Ocampo, Área de Conservación Santa Rosa Loma Larga, 18°15.164' N, 095°5.117' W, 403 m, selva alta perennifolia, 14 III 2012 (flr), *A. Campos V. et al. 7600* (MEXU).

Daniel (2001) reported this species from Mexico (Chimalapa region of eastern Oaxaca). The collection noted above extends the distribution of *Streblacanthus monospermus* (Fig. 1H) northward by about 155 km, and into the state of Veracruz. Based on morphology and molecular sequence data, this species, the type of the genus, has been shown to be only distantly related to other taxa formerly treated in *Streblacanthus* Kuntze. All other species of *Streblacanthus* are now treated in *Pachystachys* Nees (Côrtes et al. in press). The phylogenetic placement of *S. monospermus* among Justicieae has yet to be fully resolved (Daniel et al. 2008).

TETRAMERIUM NEMORUM Brandegee

Oaxaca: 45 km SW of El Camarón on Mex. 190, open places along Río Pillete, 16°24'48" N, 095°48'28" W, 570 m, 29 XI 2003 (flr), *T. Yahara et al. 2856* (MEXU).

This is the first report of *Tetramerium nemorum* (Fig. 2I) in Oaxaca. It also occurs in Guatemala, El Salvador, Honduras, Nicaragua, and in the Mexican states of Chiapas, Veracruz, and Yucatán (Daniel 1995).

TETRAMERIUM TENUISSIMUM Rose

Oaxaca: Mpio. San Juan Bautista Cuicatlán, Santiago Quiotepec, acceso a la línea eléctrica Temascal II-Oaxaca Potencia, 17°52'41.7" N, 096°58'02.9" W, selva mediana subperennifolia, 18 XII 2004 (flr) *C. Cruz E. 2170* (MEXU); Mpio. San Juan Bautista Cuicatlán, San Juan Coyula, 0.5 km SW del mesquite, sobre el Río Santo Domingo, 17°56'04" N, 096°57'26.9" W, 18 I 2007 (flr), *L. Jiménez et al. 45* (MEXU).

Although this species is not new for Oaxaca, like *Holographis leticiana* (see above), it is newly reported from the Tehuacán-Cuicatlán Valley in the northwestern portion of the state, ca. 230

km from its previously reported occurrence in the Sierra Madre Sur along the Pacific Coast (Daniel 2013b). This species also occurs in El Salvador, Guatemala, and the following Mexican states: Campeche, Chiapas, Chihuahua, Colima, Guanajuato, Guerrero, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa, Sonora, Veracruz, and Yucatán (Daniel 2004, 2012, 2013b); it is not known from Tamaulipas, as erroneously indicated by Daniel (2013b).

THUNBERGIA FRAGRANS Roxb.

Campeche: Mpio. Escárcega, Escárcega, 1-I-1966 (frt), *E. Hernández X. & J. Chavelas P. ES-644* (XAL).

This is the first report of *Thunbergia fragrans* (Fig. 2H) in Campeche. A native of India, the species is widely naturalized in the Neotropics, including Mexico (e.g., Chiapas, Hidalgo, Jalisco, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tabasco, Tamaulipas, Veracruz, and Yucatán; Daniel 2007, 2013b). Although not noted as such, it is probable that this collection is from a cultivated plant. Whether currently cultivated or naturalized in Campeche, given its propensity to become established, *T. fragrans* is likely to become more widespread in the Yucatan Peninsula in the future.

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TYPIFICATIONS IN *PHACELIA* SECT. *BARETIANA* (HYDROPHYLLACEAE)

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ABSTRACT

Phacelia sect. *Baretiana* (*Phacelia* subg. *Phacelia*) contains three taxa: *P. bolanderi, P. hydrophylloides,* and *P. procera.* Typifications and an updated key for these taxa are provided here. Lectotypes are designated for *P. hydrophylloides* and *P. procera.*

Phacelia sect. *Baretiana* Walden & R. Patt. (*Phacelia* subg. *Phacelia*) is a monophyletic clade consisting of *P. bolanderi* A. Gray, *P. hydrophylloides* A. Gray, and *P. procera* Torr. ex A. Gray (Walden 2010; Walden & Patterson 2012; Walden et al. 2014). Needed lectotypifications and pertinent discussion are given here, and an updated key to distinguish the species is also presented.

KEY TO SPECIES OF *PHACELIA* SECT. *BARETIANA*
Modified from Walden et al. (2013)

1. Plants 10–30 cm tall at maturity; inflorescence appearing capitate, generally congested or dense; stamens glabrous ..... **Phacelia hydrophylloides**
1. Plants generally > 30 cm tall at maturity (occasionally less in *P. bolanderi*, especially in water stressed plants); inflorescence appearing paniculate, generally open (at least proximally); stamens hairy.

2. Plants decumbent to ascending to substrictly erect; corolla pale blue to purple, 10–12 mm, limb 10–20 mm diam., lobe margins ± flat at anthesis, apices appearing obtuse; seeds 30–60, 1–1.5 mm ..... **Phacelia bolanderi**
2. Plants erect; corolla cream to green or brown-white, 3–7 mm, limb 7–9 mm diam., lobe margins revolute at anthesis, apices appearing acute; seeds 12–16, 2 mm ..... **Phacelia procera**

NOMENCLATURE

Phacelia Juss. sect. **Baretiana** Walden & R. Patt., Madroño 59: 215. 2012. **TYPE**: *Phacelia hydrophylloides* Torr. ex A. Gray, Proc. Amer. Acad. Arts 7: 400. 1868.

Phacelia hydrophylloides Torr. ex A. Gray, Proc. Amer. Acad. Arts 7: 400. 1868. **LECTOTYPE**: (designated here): **California**. [Mariposa Co: Lake Tenaya, Yosemite Valley, 25 Jun 1863], 1860–62, *W.H. Brewer 1688* (GH00395036 digital image! [mounted with GH00395937 and GH00395038]; isolectotypes: NY00083918 digital image! [mounted with NY00083916 and NY00083917], US322323-01160495 digital image!, YU002018 digital image!, K000662541! [mounted with *Bolander 2092* (likely *Brewer 2062*) and *Bolander 4893*]).

SYNTYPES: **California**. [Alpine Co: Near camp at Ebbett's Pass, alt. 8500–9000 ft, 7 Aug] 1863, *W.H. Brewer 2062* (GH00395037 digital image! [mounted with GH00395936

and GH00395038]; isosyntypes: NY00083917 digital image! [mounted with NY00083918 and NY00083916], YU002021 digital image!, US322325-01160494 digital image!, UC24381!, K000662541! [mounted with *Bolander* (likely *Brewer*) *1688* and *Bolander 4893*]). Mariposa Co.: Yosemite Trail, 5000–8000 ft, 1866, *H.N. Bolander 4893* (GH00395038 digital image! [mounted with GH00395936 and GH00395037]; isosyntypes: NY00083916 [mounted with NY00083918 and NY00083917], US322306-01160493 digital image!, BM000502675 digital image!, YU002020 digital image! [Yosemite Valley], NY00083915 digital image! [Yosemite Valley], UC24380!, K000662541! [mounted with *Bolander* (likely *Brewer*) *1688* and *Bolander 2092* (likely *Brewer 2062*)]).

In the protologue, Gray (1868) cited two collections made by Brewer (Ebbett's Pass and near Lake Tenaya) and one collection made by Bolander (Yosemite); specimens of those collections in GH are syntypes; duplicates of those collections are isosyntypes. Whether or not Gray saw specimens in Torrey's personal herbarium, which was sold to Columbia College and is now incorporated in NY (Britton 1887; Reveal 2014), is not known. Some specimens stamped Torrey Herbarium in NY are doubtless duplicates of specimens cited by Gray. Specimens at Kew are given with Bolander as the collector and the collection number 2092 [not 2062], but these were received from Gray and are included here as duplicates.

Jepson (1943) considered Ebbett's Pass to be the type locality for the name *Phacelia hydrophylloides* (UC24381). In 1998, D. Atwood annotated *Brewer 1688* (NY00083918) as the holotype of *Phacelia hydrophylloides*. Neither Jepson nor Atwood effected lectotypification.

Phacelia bolanderi A. Gray, Proc. Amer. Acad. Arts 10: 322. 1875 [as Bolanderi]. **TYPE: California**. Mendocino Co.: Cottanaby Creek, 20 mi N of Noyo, Jun 1867, *H.N. Bolander 6575* (holotype: GH0093199 digital image! [type in two pieces, left side of sheet, mounted with non-type specimen *V. Rattan 60*]; isotypes: US322310-00110479 digital image!, NY00083962 digital image!, UC24315!, K001096014!).

Some details were not included in the protologue (e.g., collector, collection number, date) (Gray 1875). Gray (1876, p. 509; 1878, p. 165) later added the collector information [as "*Bolander.*"] Jepson (1943, p. 252) included the collection number. The type is annotated in Gray's hand as "Phacelia Bolanderi (Eutoca) n. sp."

The type is mounted with a non-type specimen at the right side of the sheet [California. Humboldt Co.: South of Trinity River, 1878, *V. Rattan 60* (GH)]. The type consists of a large flowering plant (in two parts) to the left and in the middle of the sheet. The distal part of the inflorescence is the left side of the sheet, and the lower portion of the flowering stem is mounted in the middle of the sheet. *Rattan 60* (without a separate accession number) is the fruiting plant to the right side of the sheet.

The date on the label of *Bolander 6575* (GH) is given as 1867 June, the year and month being handwritten. The duplicate specimen at US has a typed label with the date 1866, with the year crossed out and '7' (as '1867') handwritten. The duplicate specimen at NY has a typed label, but the typed date of 1866 has no correction. The specimen at K has the year handwritten with a '7,' sent by Gray [1/75] and included as a duplicate here. Bolander was based in San Francisco in 1866 and traveled north to Mendocino earlier in the year, but he left for Yosemite Valley at the beginning of June for the duration of the summer (Bolander 1866). In 1867, Bolander traveled through Mendocino and Humboldt for June (Bolander 1867), and it was on this trip that the type specimen for *Phacelia bolanderi* was likely collected and sent to Gray.

Phacelia procera A. Gray, Proc. Amer. Acad. Arts 10: 323. 1875. **LECTOTYPE**: (designated here): **California**. [Nevada Co.]: Bear Valley, in fence corners of rich meadows, 4–7 ft. high, 4000 ft, Jul, *H.N. Bolander s.n.* (GH000395040 digital image! [mounted with GH000395039]; isosyntype: GH00093451 digital image!). The isosyntype is mounted with non-type specimen: **California**. Siskiyou Co.: South fork of Scott River, 7000 ft, Salmon trail, 24 Aug 1876, *E.L. Greene 1023* [GH no accession number, mounted with *Bolander et al.* GH00093451]).

SYNTYPES: **California**. Sierra Co.: Bear Valley, in corners of rich meadows, 4000 ft, Jul 1874, *J.G. Lemmon & c.* [*5253*] (GH000395039 digital image! [mounted with GH000395040]; PH00028288 digital image!, K! [no accession number]).

Gray (1875) referenced two collections (Bolander and Lemmon) and two counties (Nevada and Sierra) in the protologue, although both localities have the same place name of Bear Valley. The Bolander isosyntype (GH00093451) has a Plantae Californiae label with collectors of H.N. Bolander and A. Kellogg (spelled as Kellock) and is from Bear Valley along the border of Nevada and Placer counties, near Emigrant Gap. The Lemmon collection is from the Bear Valley of Sierra County, near Sardine Point.

In a later treatment, Gray (1878) added a non-type specimen (*Greene 1023*) and expanded the range; this specimen is mounted on the same sheet with the GH isosyntype (GH00093451). Some interpretation of the isosyntype sheet of *Bolander et al* (GH00093451) is necessary, as it has two plants mounted and overlaid each other. I interpret the larger plant, consisting of a flowering stem bent in the middle, as the isosyntype specimen of *Bolander et al* (GH00093451). This plant approximates the state of the *Bolander et al.* syntype (GH000395040) and the *Lemmon* syntype. The non-type specimen of *Greene 1023* is the smaller plant, a flowering stem in two fragments, with the pieces mounted on top of the *Bolander et al.* plant. The *Greene 1023* has a lower portion of the stem mounted on the left side of the sheet above the "Plantae Californicae" label, with a distal portion of the inflorescence in the middle of the sheet beneath the "Flora of N. California" label.

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CAMELLIA SASANQUA (THEACEAE) IN THE ARKANSAS FLORA

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ABSTRACT

Camellia sasanqua Thunb. is reported here as new to the Arkansas flora, the first definitive occurrence of the genus *Camellia* outside of cultivation in the state. Two spontaneous plants of *C. sasanqua* were discovered growing in disturbed, urban woods along a riparian zone in Clark County. Photographs of plants of the species are provided, along with additional notes on the genus in Arkansas.

Camellia is a genus of about 120 species of evergreen shrubs and trees widely distributed over eastern Asia (Bailey & Bailey 1976; Min & Bartholomew 2007). A few species, such as *C. sasanqua* (fall–flowering camellia), *C. japonica* (Japanese camellia), and *C. reticulata* (to–tsubaki), are prominent, highly regarded ornamentals in warm–temperate regions for their large, showy, colorful flowers and glossy, evergreen foliage (Bailey 1949; Min & Bartholomew 2007). *Camellia sinensis* is the most economically important species in the genus, as it is the commercial source of tea, which is obtained from the young leaves (Bailey & Bailey 1976; Min & Bartholomew 2007). In China, the seeds of *C. oleifera* are an important source of oil used in cooking, with a number of other species also used on a more localized basis for oil production (Min & Bartholomew 2007). Species of *Camellia* have alternate, simple, toothed leaves and perfect (bisexual), often large, solitary or paired flowers arranged in axillary inflorescences. The fruit is a large, few–seeded capsule.

Camellia sasanqua is a large, evergreen shrub or small tree to 5 meters tall that is native to Japan (Bailey & Bailey 1976; Krüssmann 1976) (Fig. 1). This species is an easily grown ornamental with attractive, glossy, evergreen foliage and flowers ranging in color from white to lavender, pink, rose, or magenta. It requires well–drained, neutral to mildly acidic soil and thrives under partial shade conditions (Bailey & Bailey 1976). As a consequence of these attributes, *C. sasanqua* regularly is cultivated in the southern USA, including Arkansas, and has been reported as a component of the naturalized floras of Florida, Georgia, and the Carolinas (Kartesz 2015; USDA, NRCS 2016), and documented by Weakley (2015) as a waif in Florida, Georgia, and South Carolina.

Camellia sasanqua has the capability to prolifically self–seed (Serviss & Peck 2008). In Arkansas in 2005, well over 100 spontaneous juvenile *C. sasanqua* plants were documented among different locations in Clark County. These plants, however, were present in the vicinity of cultivated, reproductive–age individuals of *C. sasanqua*, which themselves were undoubtedly the source of the spontaneous plants (Serviss & Peck 2008) (Figs. 2–4).

Figure 1. *Camellia sasanqua* (photographs taken from cultivated plants). (A) Flower. (B) Mature fruits. (C) Bark. (D) Leaves. (E) Flowers and habit.

Figure 2. Spontaneous juvenile plants of *C. sasanqua* in Clark County. Dozens of spontaneous plants of *C. sasanqua* were present at this site; eight of these juvenile plants are shown in the photograph (indicated by yellow–colored arrows). These spontaneous plants were produced via self–seeding from a single, large cultivated tree of *C. sasanqua* that also was present.

Figure 3. Spontaneous juvenile plants of *C. sasanqua* in Clark County (from a different location than the plants shown in Fig. 2). Several spontaneous plants of *C. sasanqua* were present at this site; four of these juvenile plants are shown in the photograph (indicated by yellow arrows). Two large, cultivated shrubs of *C. sasanqua* also were present and are the presumed source of the spontaneous juveniles.

Figure 4. Close–up view of spontaneous *C. sasanqua* plants from the same location as those shown in Fig. 3 showing some of the diversity in size among individuals. (A) Small plant (less than 10 cm tall). (B) Larger plant (ca. 75 cm tall).

In 2016, two spontaneous plants of *Camellia sasanqua* were documented at the edge of a ravine in highly disturbed, urban woods/greenbelt along a riparian zone in Clark County (Figs. 5–6). The site directly borders a residential area, and in addition to *C. sasanqua*, a number of other non–native angiosperm species were present and naturalized, including *Hedera helix* (English ivy), *Ilex cornuta* (Chinese holly), *Ligustrum sinense* (Chinese privet), *Liriope spicata* (creeping lilyturf), *Lonicera japonica* (Japanese honeysuckle), *Photina serratifolia* (Chinese photina), and *Vinca major* (greater periwinkle). The larger of the two *C. sasanqua* plants was 4.6 m tall with mature fruits and seeds (Fig. 5). The second plant was smaller, nearly 2 m tall, and located ca. 1.5 m away from the larger plant (Fig. 6). It is probable, based on the tendency of *C. sasanqua* to prolifically self–seed,

Figure 5. Photographs of leaves, mature fruits, and seeds from the larger spontaneous plant of *C. sasanqua* (notice the pubescence on the stems, leaves, fruit, and seed). (A) Mature fruit. (B) Mature fruit and one large, brown seed. (C) Stems and leaves.

Figure 6. Spontaneous plant of *C. sasanqua* in disturbed, urban woods in Clark County, Arkansas. This plant was sterile and nearly 2 m tall.

that the smaller plant was generated directly via seed from the larger individual. The origin of the larger plant is unknown; however, a large, cultivated plant of *C. sasanqua* was present at the edge of the residential area, across a street from the ravine. Based on observations provided by Diamond (2013) of eastern grey squirrels (*Sciurus carolinensis*) feeding on and burying seeds of *C. japonica* (the seeds of *C. sasanqua* are very similar in size, color, and shape to those of *C. japonica*), it is reasonable to surmise that squirrels may have transported seeds from the cultivated *C. sasanqua* plant into the adjacent woods, allowing for subsequent establishment of one or both of the *C. sasanqua* plants. Diamond (2013) also reported that the spontaneous occurrence of *C. japonica* in Alabama was, in fact, facilitated by dispersal of seeds by eastern grey squirrel.

Voucher specimens: **Arkansas.** Clark Co.: Two spontaneous plants at edge of ravine in disturbed, urban woods/greenbelt along riparian zone, along University Drive, adjacent to the intersection of University Drive and 10th Street (Hwy 7/67), Arkadelphia, 11 Apr 2016, *Serviss 8228* (HEND); Numerous spontaneous seedlings, some to ca. 75 cm tall, in the vicinity of two large, cultivated shrubs of *C. sasanqua*, Ross House area off of Henderson Street, HSU campus, Arkadelphia, 29 May 2005, *Serviss 6985* (HEND); Dozens of spontaneous juvenile plants in a semi–unkempt area of home site in the vicinity of a large, cultivated tree of *C. sasanqua*, ca. one–half block N of intersection of 12th Street and Huddleston Street, Arkadelphia, 18 Mar 2005, *Serviss 6861* (HEND).

Figure 7. *Camellia japonica* for comparison with *C. sasanqua* (photographs taken from cultivated plants, except Fig. C). (A) Mature fruit. (B) Mature seeds. (C) Spontaneous juvenile plant of *C. japonica* from Clark County, Arkansas. (D) Leaves. (E) Bark. (F) Flowers and habit.

Camellia sasanqua is morphologically similar to *C. japonica* (Fig. 7) and spontaneous plants of *C. japonica* also have been documented from Arkansas (Serviss & Peck 2008) as well as a few other southern states (Diamond 2013; Weakley 2015). Consequently, *C. japonica* may be encountered in Arkansas outside of cultivation, where it could potentially be confused with *C. sasanqua*. *Camellia sasanqua* may be reliably distinguished from *C. japonica* by its pubescent stems (on new growth) and leaves (along midvein of upper surface) and pubescent ovaries and fruits. *Camellia japonica*, in contrast, has completely glabrous foliage, ovaries, and fruits.

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ON *SOLIDAGO GYPSOPHILA* AND *S. PRINGLEI* (ASTERACEAE: ASTEREAE), RARE AND NOT SO RARE MEXICAN ENDEMICS: A MULTIVARIATE STUDY OF THE *TORTIFOLIA* GROUP OF SUBSECT. *TRIPLINERVIAE*

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ABSTRACT

Nesom (1989) described *Solidago gypsophila* based on three collections from central Coahuila, Mexico. It is investigated here in a multivariate morphometric analysis that also includes specimens of *S. altiplanities*, *S. altissima* var. *gilvocanescens*, *S. juliae*, *S. leavenworthii*, *S. microglossa*, *S. pringlei*, and *S. tortifolia* (the informal *S. tortifolia* Group) in order to determine similarities among species. Because only one specimen of *S. gypsophila* was scored, it could not be included as an a priori group but it was included in the a posteriori classificatory discriminant analysis and placed in *S. altissima* var. *gilvocanescens* on the basis of upper leaf and floral traits. In a second analysis, including only *S. chilensis*, *S. juliae*, *S. pringlei*, and *S. tortifolia*, the specimen of *S. gypsophila* was placed a posteriori into *S. juliae*, but on the basis of leaf indument traits, phyllary shape, ecology, and distribution it is accepted here as a distinct species. Morphological variation in *S. pringlei* (syn: *S. muelleri*) is also explored and discussed. Detailed illustrations of *S. gypsophila* and *S. pringlei* are presented.

Nesom (1989a) described *Solidago gypsophila* Nesom but did not illustrate the new species. He stated that it was "similar and obviously related to *S. canadensis* var. *canescens* A. Gray in its villous stem pubescence, crowded leaves, large, triangular capitulescence with few disc flowers." Nesom (1989b) treated *S. canadensis* var. *canescens* as a synonym of *S. juliae* Nesom as did Semple & Cook (2006). Upon examining the holotype of *S. gypsophila* (*Henrickson 15576*, LL!), the first author noted similarities of the robust specimen (Fig. 1) to *S. altissima* L. var. *gilvocanescens* (Rydb.) Semple; the leaves (Fig. 2) are much broader than those of *S. juliae* and the inflorescence is broadly secund-conical, while those of *S. juliae* are much narrower. In addition to the short, dense, curved trichomes covering much of the leaf surface, there are also small minute short bumps of unknown composition (Fig. 3). The phyllaries are broader (Figs. 4C-D, 5C) than those of *S. altissima* var. *gilvocanescens* and most other species of *Solidago* subsect. *Triplinerviae* (Torr. & A. Gray) Nesom except for *S. leavenworthii*. Some specimens of *S. pringlei* Fern. and *S. chilensis* Meyen. The rugose venation and surface indument features of *S. gypsophila* are unique to the species in subsect. *Triplinerviae* and the entire genus *Solidago*. Nesom (1989a) was certainly correct in treating *S. gypsophila* as a distinct species.

Solidago pringlei Fernald (1901) was described from a collection from Nuevo León, Mexico: (*Pringle 2886*, GH!). Subsequently *Solidago muelleri* Standley (1940) was described from a different collection from Nuevo León (*Mueller 2062*, F!, GH!). Nesom (1989a) treated *S. muelleri* as a synonym of *S. missouriensis* Nutt. in his comments on *Solidago hintoniorum* Nesom, but he annotated the isotype of *S. muelleri* at GH as *S. pringlei* in 1990. A collection from southeast of Galeana, Nuevo León, (*Henrickson 19260,* TEX) was identified on the collection label as *S. altissima*, annotated by B.L. Turner in 1985 as *S. missouriensis*, then annotated by Nesom in 1989 as *S. muelleri* and again in 1990 annotated

as *S. pringlei*. *Nesom & Morgan 5302* (TEX) includes a small shoot and a larger one. Nesom identified the collection on the location label as *S. missouriensis* in 1989 then annotated the sheet as *S. muelleri* in 1989 and then again as *S. pringlei* in 1990. The first author of this paper annotated the larger shoot as *S. pringlei* in 2016 and the smaller one as *S. missouriensis* in 2016. There are not a large number of collections of *S. pringlei* (or *S. muelleri*) in herbaria based on loans requested for this study. Its range is relatively narrow but includes noteworthy variation in stem pubescence densities, numbers of leaf serrations, and in phyllary shape and width. *Solidago pringlei* has been included in subsect. *Triplinerviae* by Nesom (1994) and by Semple (2016, frequently updated).

In order to explore morphological similarities and differences among *Solidago gypsophila* and likely related species, a multivariate morphometric comparison of *S. gypsophila* and *S. altissima* var. *gilvocanescens* was undertaken and included specimens of *S. altiplanities* Taylor & Taylor, *S. juliae, S. leavenworthii* Torr. & A. Gray, and *S. tortifolia* Ell. from the southcentral and southeastern USA., *S. pringlei* from Mexico, and *S. chilensis* Meyen and *S. microglossa* DC. from South America. These species have been grouped into the informal *Tortifolia* Group by Semple (2016, frequently updated). The results of the analysis are presented below. These analyses also allowed comparisons of *S. pringlei* with other related species.

Nomenclature

Solidago gypsophila Nesom, Phytologia 67: 142. 1989 **TYPE**: **MEXICO**. **Coahuila**. Mpio. Cuatro Cienegas, ca 9 air mi SW of Cuatro Cienegas, ca 2 mi N of Poza Becerra, in a fen-like area, with *Flaveria, Baccharis, Sciprus, Anemopsis, Sporobolus, Distichlis*, coarse perennial, lvs gray-green, fls yellow, 26° 52' N, 102° 08' W, 709 m, 10 Oct 1976, *J. Henrickson 15576* with M. Dillon (holotype: LL!, Figs. 1-4).

Additional collections examined: **MEXICO**. **Coahuila**. Mpio. Cuatro Ciene Grande, Cuatro Cienegas Basin, small laguna between Lagunas Churince and Grande, 13 Aug 1967, *Cole, Minckley, & Pinkava 3790* (ASU!, almost in flower, disc florets corollas not open); Dos Quatos, 21 Aug 1967, *Cole, Minckley & Pinkava 4336* (ASU!, immature, very small inflorescence buds present).

Solidago pringlei Fern., Proc. Amer. Acad. Arts 36: 505. 1901. **TYPE**: **MEXICO**. **Nuevo León**. Near Monterey, Sierra Madre, 22 Aug 1889, *C.G. Pringle 2886* (holotype: GH!, Fig. 5).

Solidago muelleri Standl., Field Mus. Pub. Bot. 22: 128. 1940. **TYPE**: **MEXICO**. **Nuevo León**. Mpio. de Villa Santiago, Cañon Marisio Abajo, Rancho Las Adjuntas, common in moist crevices on river bank, f.c. deep yellow, 27 Jun 1935, *C.H. Mueller 2062* (holotype: F 888438!, Fig. 6; isotypes: GH!, MICH digital image!, MO digital image!).

Additional collections examined: **MEXICO**. **Coahuila**: Sierra la Gavia, Rancho la Gavia, 25 Oct 1995, *Villarreal & Carranza 3366* (TEX). **Nuevo León**: near Monterey, Sierra Madre, 12 Aug 1889, *Pringle 1586* (MEXU); Sierra Madre near Monterrey, 22 Aug 1889, *Pringle 2586* (MEXU PVT33274, digital image); Mpio. Galeana, 10 km E of Galeana, Pocitos, 26 Aug 1984, *Hinton 18780* (UNAM Herb Hinton, digital image), Enramadas, 20 Mar 1992, *Hinton 21858* (UNAM Herb. Hinton, digital image); Montemorelos, at La Trinidad, 10 Aug 1988, *Patterson 6434* (TEX); 5 km S Galeana, near concrete bridge 0.5 km to E of main road, 31 Nov 1985, *Nesom & Morgan 5302* (TEX); ca 15 air km SE of Galeana, just S of Cerro Potosí at old abandoned settlement at Santa Rita de Cardeladas, 10 Oct 1982, *Henrickson & Hess 19260* (TEX); Santa Rita, 23 Mar 1993, *Hinton 22721* (TEX, UNAM Herb. Hinton, digital image); above Santa Rita, 12 Jan 1989, *Hinton 19300* (UNAM Herb. Hinton, digital image); Villa de Santiago, Las Adjuntas, 21 Jun 1940, *Leavenworth 180* (GH, TEX); Rio Ramos near Los Adjuntas, in Sierra Madre, 5 Sep 1992, *Soule, Patterson, & LeDuc 3263* (TEX); Santa Rita, 23 Mar 1993, *Hinton et al. 19300* (TEX); N of La Trinidad on road from [Portrero] Redondo, 5 Sep 1992, *Soule, Patterson, & LeDuc 3289* (TEX).

LUNDELL HERBARIUM
The University of Texas
AUSTIN, TEXAS
Cite: LL
00373655
California State University, Los Angeles
PLANTS OF MEXICO
Solidago altissima L.
Coahuila, Mexico; ca 9 (air) miles SW of Cuatro Cienegas, ca 2 miles N of Poza Becerra, in a fen-like area; with Eleocharis, Baccharis, Scirpus, Anemopsis, Sporobolus, Distichlis, etc.
Coarse perennial, lvs. gray-green, fls. yellow.
709 M
October 10, 1976
Near 26° 52' N. 102° 08' W
James Henrickson w/ N. Dillon 15576 8
The University of Texas Herbarium
S. canadensis var gypsophila var nov.
B. L. Turner 1985

Figure 1. Holotype of *Solidago gypsophila* (*Henrickson 15576*, LL).

Figure 2. Details of holotype of *Solidago gypsophila*: stem and leaves. **A-B.** Lower mid stem. **C.** Upper stem. **D.** Lower mid stem leaf. **E.** Upper leaf. **F-G.** Lower mid stem leaf apex and margin, abaxial face. **H-J.** Upper leaf, abaxial face, upper mid-section, aveolae, proximal mid vein and prominent lateral veins. Scale bar = 1 cm in D and E; = 1 mm in A-B, F, G-J.

Figure 3. Detail of holotype of *Solidago gypsophila*: abaxial face of upper mid-section of upper leaf. Scale bar = 1 mm.

Multivariate Analysis

MATERIALS AND METHODS

In total, 216 specimens from BM, BRIT, F, FSU, GH, the J.K. Morton personal herbarium now deposited in ROM, K, LL, LP, MADM, MEL, TEX, USF, and WAT in MT (Thiers, continuously updated) were scored and included in the analysis. Data on *Solidago chilensis* (92 specimens), *S. juliae* (11 specimens), *S. leavenworthii* (15 specimens), *S. microglossa* (31 specimens), and *S. tortifolia* (16 specimens) were measured by the second author for her M.Sc. thesis (Lopez Laphitz 2009) and in Lopez Laphitz and Semple (2011), except for a few specimens scored by the author since 2009. Data on *S. altiplanities* (9 specimens) and *S. altissima* var. *gilvocanescens* (29 specimens) were previously used in Semple et al. (2015). New data on *S. gypsophila* (one specimen) and *S. pringlei* (12 specimens) were scored for this study by the first author. For each specimen, 13 vegetative and 16 floral traits were scored when possible: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait. All traits scored are listed in Table 1. Phyllary width traits were not scored on specimens of *S. altissima* var. *gilvocanescens* and were scored on only two specimens of *S. altiplanities*.

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics, lower stem pubescence density, and leaf pubescence density were used to define a priori groups along with geographic location. Lower stem leaf traits were not included in the analyses because these were often not present on specimens.

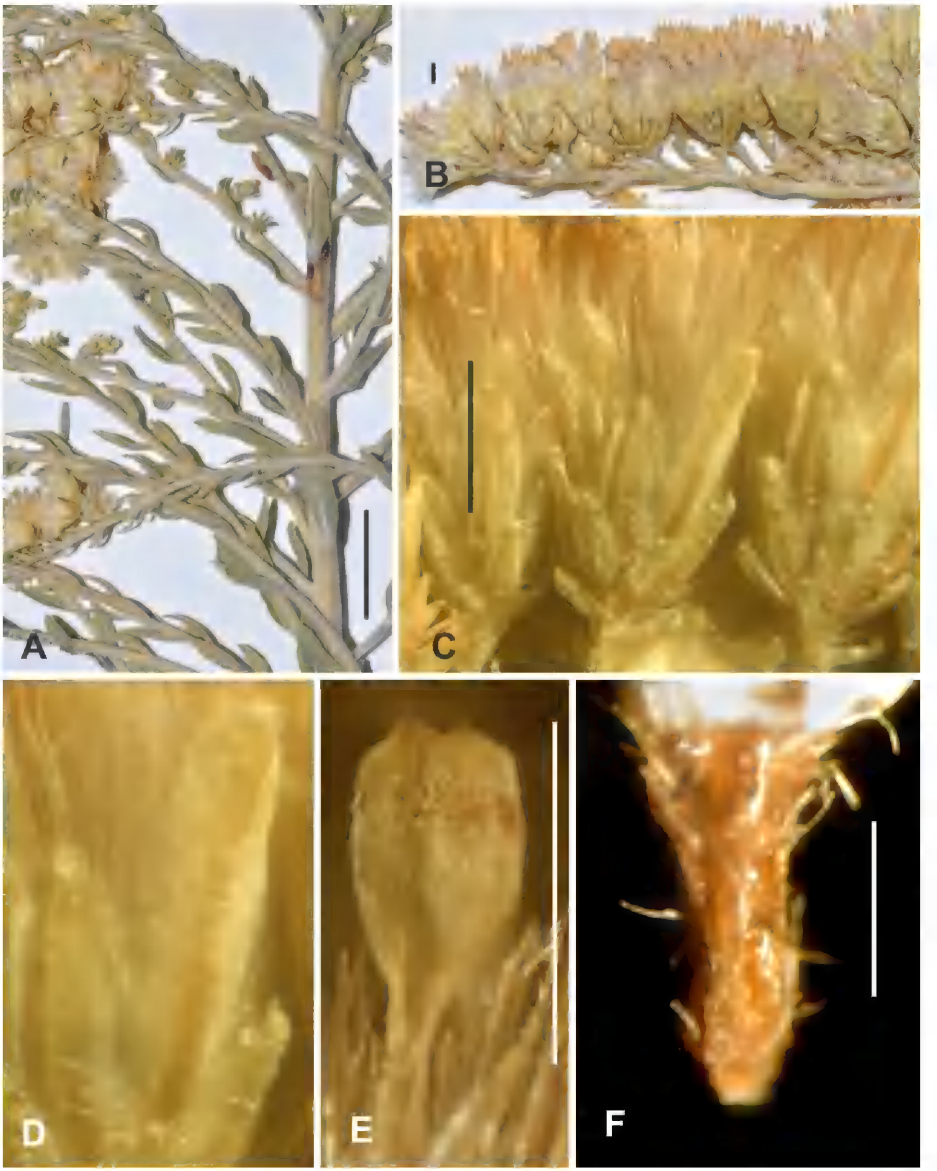

Figure 4. Details of holotype of *Solidago gypsophila*: inflorescence, heads and florets. **A.** Upper mid portion of inflorescence. **B.** Heads of lower branch of inflorescence. **C.** Involucres. **D.** Mid and inner phyllaries. **E.** Ray floret lamina. **F.** Immature cypsela body (ca. 0.5 mm long). Scale bar = 1 cm in A; = 1 mm in B, C, E; = 0.5 mm in F.

Figure 5. Details of *Solidago gypsophila* (*Cole, Minckley, & Pinkava 3790*, ASU). **A-B.** Inflorescences. **C.** Phyllaries. Scale bar = 1 cm in A-B; = 1 mm in C.

Figure 6. Holotype of *Solidago pringlei* (*Pringle 2886*, GH).

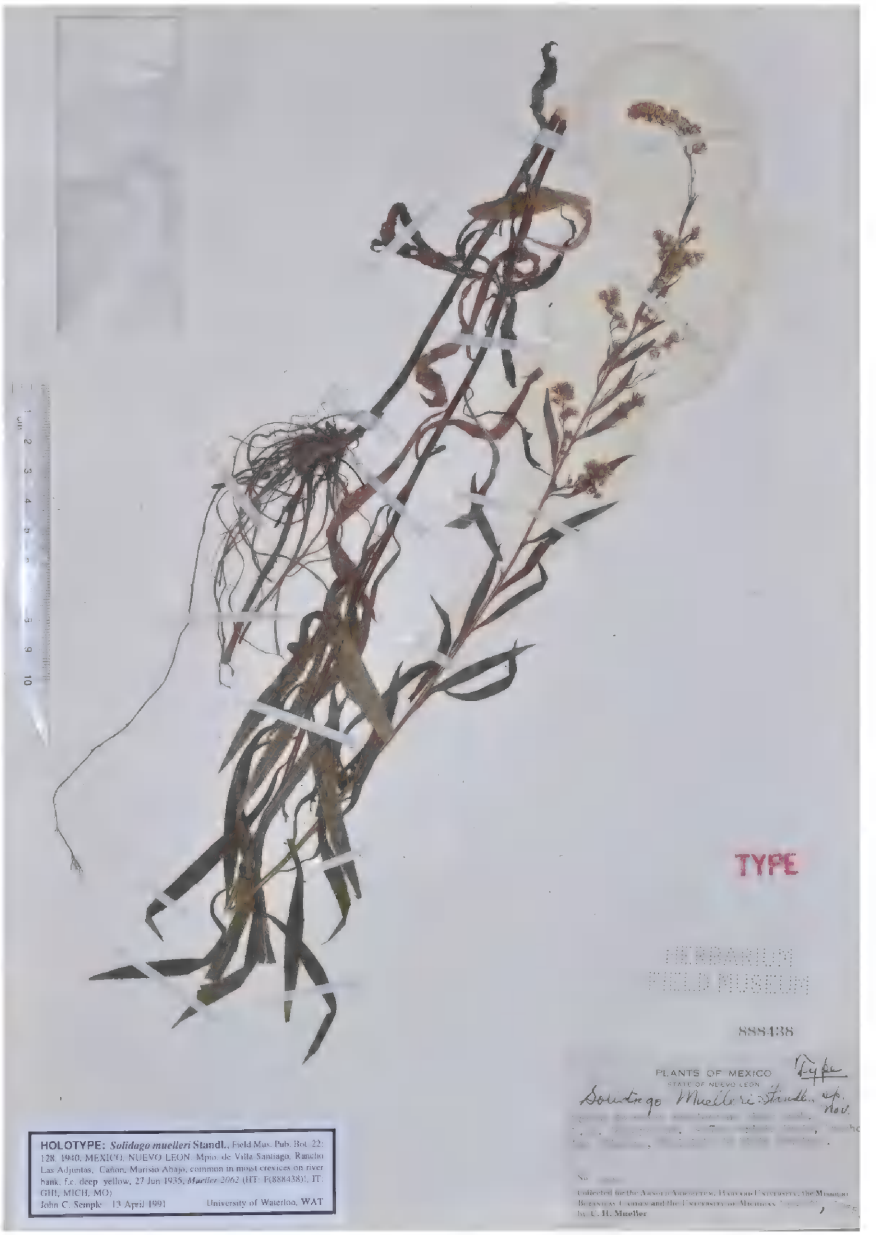
TYPE
HERBARIUM
FIELD MUSEUM
888438
PLANTS OF MEXICO
STATE OF NUEVO LEON
Solidago Muelleri Standl., sp. nov.
HOLOTYPE: Solidago muelleri Standl., Field Mus. Publ. Bot. 22: 128. 1940; MEXICO: NUEVO LEON: Mpio. de Villa Santiago, Rancho Las Adjuntas, Cañon, Marisio Abajo, common in moist crevices on river bank, fr. deep yellow, 27 Jun 1935, Mueller 2062 (HT: F888438!, IT: GH!, MICH!, MO)
John C. Semple 13 April 1991
University of Waterloo, WAT

Figure 7. Holotype of *Solidago muelleri* (*Mueller 2062*, F).

Figure 8. Details of *Solidago pringlei*: stem and leaves. **A-B.** Lower and mid stems, *Leavenworth 180* (GH). **C-D.** Upper stem, *Nesom & Morgan 5302* (TEX). **E.** Rhizome and new shoot leaves, *Hinton 21858* (TEX). **F.** Lower stem leaf, *Hinton 22721* (TEX). **G-H.** Mid stem leaf and apex, *Patterson 6434* (TEX). **I.** Upper stem and leaves, *Villareal 8366* (TEX). **J.** Leaves, base of inflorescence, *Henrickson & Hess 19260* (TEX). Scale bar = 1 mm in A-D; = 1 cm in E-J.

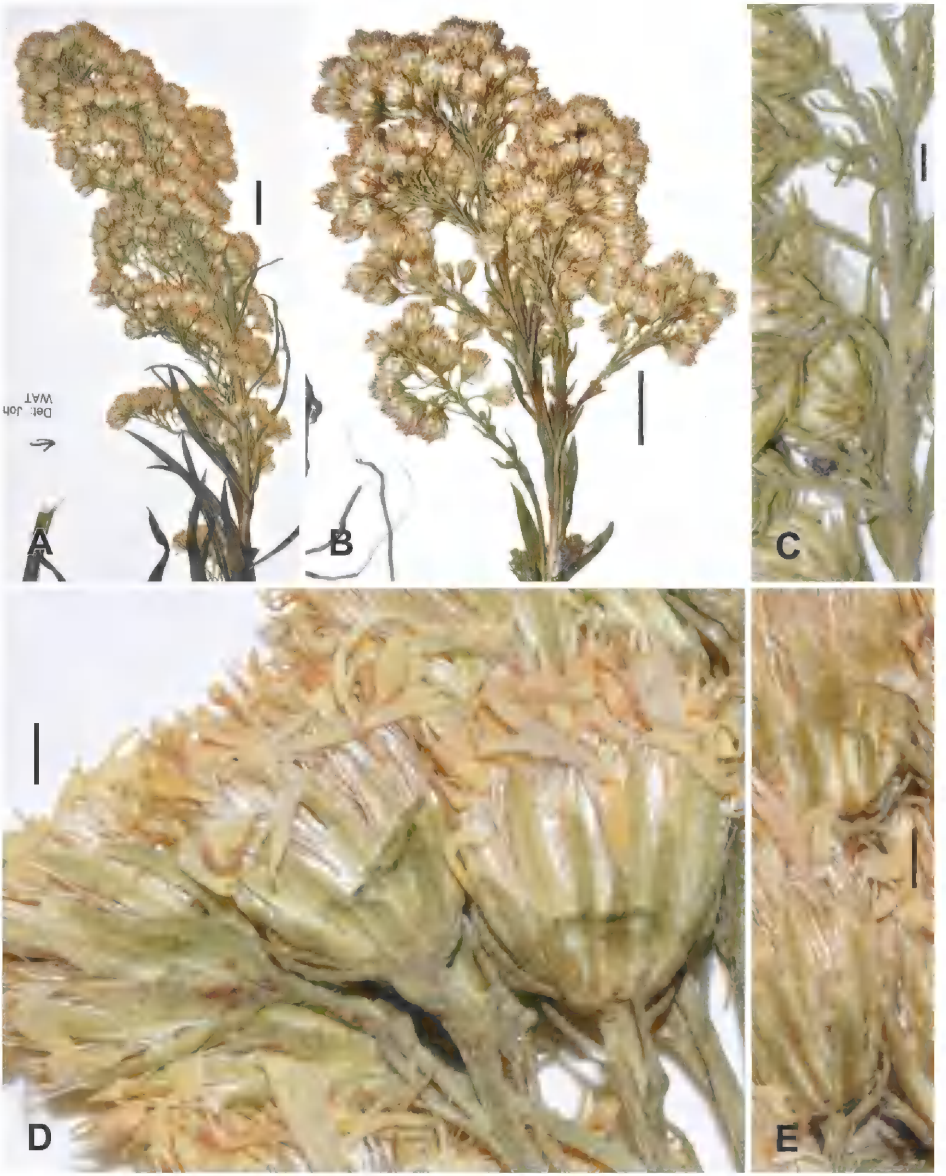

Figure 9. Details of *Solidago pringlei*; inflorescences, heads, florets. **A-B.** Inflorescences, *Nesom & Morgan 5302* (TEX) and *Henrickson & Hess 19260* (TEX). **C.** Peduncles and bracts, *Soule et al. 3263* (TEX). **D.** Heads with lanceolate phyllaries, *Hinton 22721* (TEX). **E.** Heads with some oblong phyllaries, *Hinton 19300* (TEX). Scale bar = 1 cm in A-B; = 1 mm in C-E.

Table 1. Traits scored for the multivariate analyses of specimens of *Solidago altiplanities*, *S. chilensis*, *S. gypsophila*, *S. juliae*, *S. leavenworthii*, *S. microglossa*, *S. pringlei*, and *S. tortifolia*.

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
LLFLN	Lower leaf length measured from the leaf base to tip(mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end(mm)
LLFSER	Lower leaf dentation-number of serrations of lower leaf
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf dentation-number of serrations of mid leaf
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end(mm)
ULFSER	Upper leaf dentation-number of serrations of upper leaf
CAPL	Length of inflorescence (cm)
CAPW	Width of inflorescence (cm)
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
OPHYLW	Outer phyllary width (mm)
IPHYLN	Inner phyllary length (mm)
IPHYLW	Inner phyllary width (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)

All analyses were performed using SYSTAT v.10 (SPSS Inc. 2000). A pair-wise Pearson correlation matrix was created to determine which characters were highly correlated. One trait of each pair that had a $> |0.7|$ correlation value was excluded from the analysis to avoid possible pleiotropic effects of a single gene and to make the tests of null hypotheses more stringent. Stepwise discriminant analysis (STEPDISC) was used to select traits that best separated groups based on the Mahalanobis distances between a priori group centroids in N-dimensional hyperspace. Classificatory discriminant analysis was run on N-1 traits selected by the STEPDISC analysis, if more than N-1 traits were selected, where N = lowest sample size of the a priori groups; in this study N=9 (*Solidago altiplanities*). A COMPLETE analysis was then run using only eight traits. Geisser probabilities of assignment to each a priori group were generated for each specimen a posteriori based on the Mahalanobis distances from the specimen location plotted in N-dimensional hyperspace to each a priori group centroid. Linear and

Jackknifed analyses were run in each classificatory analysis to test the strength of group separation in terms of the numbers of discriminating traits. Results are presented in the form of (1) F-value matrices based on Mahalanobis distances between group centroids and (2) tables summarizing the results of the two methods of doing the classificatory discriminant analyses. Conclusions were reached based on the percents of correct placements of specimens and the probabilities of the placements being correct and visual re-examination of each specimen via high resolution digital images or the actual specimens. Lastly, a canonical analysis was performed as a dimension reduction technique to allow visualization of results in 1 to 3 dimensions with the number of dimensions being N-1, where in this case N equals the number of a priori groups in an analysis. While canonical analysis allows for a visual presentation of results, the plots are based on fewer axes than are used in the statistical analyses and thus do not fully show the multi-dimensional nature of the separation of a priori groups.

Two analyses were performed. One included all taxa and all specimens scored. A second analysis was run on just specimens of *Solidago chilensis*, *S. juliae*, *S. pringlei*, and *S. tortifolia* as four a priori groups and the one specimen of *S. gypsophila* a posteriori. This was done because the species are all diploids and whose members were sometimes misplaced into the other taxa in the eight-group analysis. Any influence of ploidy level would be avoided by including only these taxa. *Solidago microglossa* was excluded because its distinctive long pubescence was not seen in the Mexican species.

RESULTS

Eight-taxa analysis

In the COMPLETE discriminant analysis of seven species level a priori *Solidago altiplanities*, *S. altissima* var. *gilvocanescens*, *S. chilensis*, *S. juliae*, *S. leavenworthii*, *S. microglossa*, *S. pringlei*, and *S. tortifolia*, the following eight traits were used from a longer list selected in a preliminary STEPWISE analysis and are listed in order of decreasing F-to-remove values: number of ray florets (19.09), involucre height (15.99), mid leaf width (14.59), mid leaf serrations (9.97), number of disc florets (7.14), mid leaf length (6.56), ray floret cypsela pappus length at anthesis (5.81), and ray floret lamina length at anthesis (0.80). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *Solidago altissima* var. *gilvocancens* and the two South American species *S. chilensis* and *S. microglossa* (48.541 and 30.768, respectively) and the least separation was between *S. juliae* and *S. torifolia* (3.692).

In the a posteriori Classificatory Discriminant Analysis of the eight-species level a priori groups plus the one specimen of *Solidago gypsophila, S. altiplanities* was the only a priori group with 100% placement to that group a posteriori; a posteriori assignments for other groups ranged from 67-94% to their own group (Table 3). The Classification matrix and Jackknife classification matrix are presented in Table 3.

Table 2. Between groups F-matrix for the eight a priori group analysis (df = 8, 7, 204).

Group	*altiplanities*	*altissima gilvocan.*	*chilensis*	*juliae*	*leaven-worthii*	*micro-glossa*	*pringlei*
alt. gilvocan.	13.958						
chilensis	10.958	48.541					
juliae	7.429	4.984	11.763				
leavenworthii	11.329	19.645	9.535	8.103			
microglossa	16.532	30.768	7.633	9.141	8.485		
pringlei	8.874	15.794	10.977	4.360	6.167	13.525	
tortifolia	6.689	9.953	32.573	3.692	19.033	28.952	11.590

Wilks' lambda = 0.0609 df = 8 7 207; Approx. F = 13.1661 df = 56 1082 prob = 0.0000

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of eight a priori groups; a posteriori placements to groups in rows.

Group	*altiplan-ities*	*altissima gilvocan.*	*chilensis*	*juliae*	*leaven-worthii*	*micro-glossa*	*pringlei*	*torti-folia*	% correct
altiplanities	9	0	0	0	0	0	0	0	100
alt. gilvocan.	0	25	0	2	0	0	0	2	86
chilensis	5	1	62	1	7	12	4	0	67
juliae	0	2	0	8	1	0	0	0	73
leavenworthii	0	0	3	3	9	0	0	1	60
microglossa	0	0	5	1	2	23	0	0	74
pringlei	1	0	0	2	0	1	8	0	67
tortifolia	0	1	0	0	0	0	0	15	94
Totals	15	29	70	17	19	36	12	17	74

Jackknifed classification matrix

Group	*altiplan-ities*	*altissima gilvocan.*	*chilensis*	*juliae*	*leaven-worthii*	*micro-glossa*	*pringlei*	*torti-folia*	% correct
altiplanities	9	0	0	0	0	0	0	0	100
alt. gilvocan.	0	25	0	2	0	0	0	2	86
chilensis	6	1	57	1	7	15	5	0	62
juliae	0	2	0	8	1	1	0	0	73
leavenworthii	0	0	3	4	7	1	0	1	47
microglossa	0	0	5	2	2	22	0	0	71
pringlei	1	0	0	2	0	1	8	0	67
tortifolia	0	1	0	0	0	0	0	15	94
Totals	16	29	65	19	174	39	13	17	70

Results are presented in decreasing order of percent correct placement. Eight of nine specimens of *Solidago altiplanities* were placed a posteriori into the *altiplanities* group with 90-100% probability; one was placed into the group with 71% probability (19% to *S. tortifolia*, 6% to *S. juliae*, and 3% to *S. pringlei*). Fifteen of 16 specimens of *S. tortifolia* (94%) were assigned a posteriori to the *S. tortifolia* group; 9 with 90-96% probability, 4 with 81-87% probability; 2 with 73% and 67% probabilities. One *S. tortifolia* specimen was placed into the *S. altissima* var. *gilvocanescens* group with 85% probability (6% to *S. juliae*, 4% to *S. microglossa*, 2% to *S. tortifolia*, and 1% to *S. leavenworthii*). Twenty-five of the 29 specimens of *S. altissima* var. *gilvocanescens* (86%) were assigned a posteriori to the *S. altissima* var. *gilvocanescens* group; 15 with 90-100% probability, 6 with 76-88% probability; 3 with 51-53% probability. Four *S. altissima* var. *gilvocanescens* specimens were placed into other species groups: 2 into *S. tortifolia* with 80% and 63% and 2 into *S. juliae* with 59% probability (14% *S. altissima* var. *gilvocanescens*) and 37% (24 % to *S. altissima* var. *gilvocanescens*, 24% to *S. pringlei*, and 13% to *S. altiplanities*). Twenty-three of the 31 specimens of *S. microglossa* (74%) were assigned a posteriori to the *microglossa* group; 7 with 94-99% probability, 7 with 71-81% probability; 6 with 60- 66% probabilities, and 3 with 50-55% probability. Eight *S. microglossa* specimens were placed a posteriori into other species groups: 5 were placed in the *S. chilensis* group with 57-78% probability, 2 were placed in the *S. leavenworthii* group with 88% and 36% probabilities, and 1 was placed in the *S. juliae* group with 59%. Eight of 11 specimens of *S. juliae* (83%) were assigned a posteriori to the *S. juliae* group: 4 with 81-88% probability, 2 with 70-71% probability, and 2 with 65-65% probability. Three specimens of *S. juliae* were placed a posteriori into two other taxa: 2 were placed into *S. altissima* var. *gilvocanescens* with 85% probability and 50% probability (29% to *S. juliae*, 11% to *S. pringlei*, 5% to *S. tortifolia* and 4% to *S. leavenworthii*), and 1 specimen was placed into *S. leavenworthii* with 56% probability (32% to *S. pringlei*, 7% to *S. juliae*, and 4% to *S. altissima* var. *gilvocanescens*). Sixty-two of 92 specimens of *S. chilensis* (67%) were assigned a posteriori to the *S. chilensis* group; 7 with 90-96% probability, 16 with

80-87% probability; 9 with 70-79% probability, 13 with 60-69% probability, and 17 with 39-59% probability. Thirty specimens of *S. chilensis* (including most of the adventive specimens to other parts of the world) were placed a posteriori into other species: 10 specimens were placed into the *S. microglossa* group with 28-73% (14-46% to *S. chilensis*), 6 into the *S. leavenworthii* group with 37-87% probability (17-46% to *S. chilensis*); 5 into *S. altiplanities* with 52-95% probability, 2 into *S. pringlei* with 32% and 86% probabilities, and 1 into *S. juliae* with 51% probability (34% to *S. chilensis*, 16% to *S. microglossa*, and 4% to *S. pringlei*). Eight of 12 specimens of *S. pringlei* (67%) were assigned a posteriori to the *S. pringlei* group; 4 with 95-99% probability and 4 with 65-79% probability. Four *S. pringlei* specimens were placed into other species: 2 into *S. juliae* with 59% and 61% probabilities (38% and 27% to *S. pringlei*, 8% and 1% to *S. tortifolia* and *S. microglossa*, respectively), 1 to *S. microglossa* with 63% probability (36% to *S. chilensis*, and 1% to *S. pringlei*), and 1 to *S. altiplanities* with 59% probability (20% to *S. chilensis*, 12% to *S. pringlei* and 5% to *S. juliae*). Nine of 15 specimens of *S. leavenworthii* (60%) were assigned a posteriori to the *S. leavenworthii* group; 3 with 98-100% probability, 5 with 79-88% probability; and 1 with 37% probability (35% to *S. microglossa*, 10% to *S. juliae*, and 9% to *S. chilensis*). Six *S. leavenworthii* specimens ware placed into other species: 3 to *S. chilensis* 93%, 92% and 56% probability (27% to *S. leavenworthii*, 13% to *S. microglossa*, and 3% to *S. leavenworthii*). The holotype specimen of *S. gypsophila* which was not assigned to an a priori group was assigned a posteriori to *S. altissima* var. *gilvocanescens* with 73% probability (21% to *S. juliae* and 6% to *S. tortifolia*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago altiplanities*, *S. chilensis*, *S. juliae*, *S. leavenworthii*, *S. microglossa*, *S. pringlei*, and *S. tortifolia*, and the single collection of *S. gypsophila* are presented in Fig. 7. The positions of the *S. gypsophila* specimen on the two plots are indicated by yellow stars. Eigen values on the first three axes were 2.835, 0.813 and 0.488.

Four-species analysis

In the STEPWISE discriminant analysis of four-species level a priori groups (*Solidago chilensis*, *S. juliae*, *S. pringlei*, and *S. tortifolia*) and the one specimen of *S. gypsophila* included a posteriori, the following eight traits were selected and are listed in order of decreasing F to remove values: involucre height (13.60), number of ray florets (12.94), disc floret cypsela pappus length at anthesis (10.72), mid leaf length (7.47), mid leaf width (6.75), disc achene body length at anthesis (5.54), outer phyllary width at widest point (3.99), and disc floret corolla lobe length (3.94). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of $p = 0.000$ that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 4. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *Solidago chilensis* and *S. tortifolia* (24.110) and the small separation was between *S. juliae* and *S. pringlei* (3.067).

In the Classificatory Discriminant Analysis of the four-species level a priori groups plus the one specimen of *Solidago gypsophila* a posteriori, all 11 specimens of *S. juliae* (100%) were assigned to that species a posteriori: 4 with 92-94% probability, 3 with 81-86% probability, and 4 with 77%, 70%, 62% and 54% (42% to *S. pringlei*). The Classification matrix and Jackknife classification matrix are presented in Table 5. Seventy-nine of 84 specimens of *S. chilensis* (94%) native to South America were assigned a posteriori into the *S. chilensis* group; 57 with 92-100% probability, 7 with 80-89% probability, 12 with 65-77% probability, and 2 with 50-52% probability. Five specimens were assigned a posteriori to other species: 3 to *S. juliae* with 84%, 72% and 70% probabilities and 2 to *S. pringlei* with 65% and 61% probabilities. Fourteen of the 15 specimens of *S. tortifolia* (93%) were assigned a posteriori into the *S. tortifolia* group; 12 with 94-100% probability, and 2 with 89% and 78% probabilities. One specimen was assigned a posteriori to *S. juliae* with 60% probability (37% to *S. tortifolia*, 3% to *S. pringlei*). Eleven of the 12 specimens of *S. pringlei* (92%) were assigned a posteriori to the *S. pringlei* group; five with 93-99% probability (including the holotype) and 3 with probabilities of 85%, 67%, and 59% (38% to

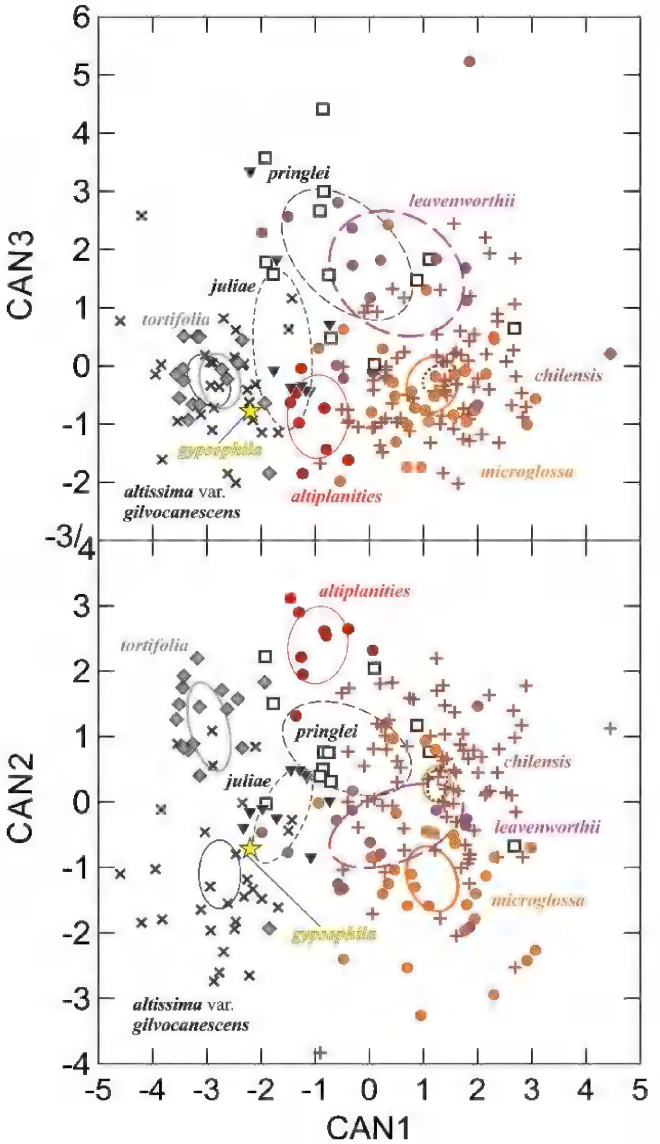

Figure 10. Plots of CAN1 versus CAN3 and CAN1 versus CAN2 of 212 specimens of *Solidago altiplanities* (red dots), *S. altissima* var. *gilvocanescens* (black ×), *S. chilensis* (brown +), *S. juliae* (black triangles), *S. leavenworthii* (purple dots), *S. microglossa* (orange dots), *S. pringlei* (white squares with black outlines), *S. tortifolia* (gray diamonds with black outlines), and the one collection of *S. gypsophila* (yellow star); 95% confidence ellipses are included.

S. juliae). One specimen, the GH isotype of *S. muelleri*, was assigned a posteriori to the *S. juliae* group with 53% probability (42% to *S. pringlei*, 5% to *S. tortifolia*). The single specimen of *S. gypsophila* was assigned a posteriori to *S. juliae* with 95% probability (4% to *S. tortifolia* and 1% to *S. pringlei*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago chilensis*, *S. juliae*, *S. pringlei*, *S. tortifolia*, and the single collection of *S. gypsophila* are presented in Fig. 11. The positions of the *S. gypsophila* specimen on the two plots are indicated by yellow stars. Eigen values on the first three axes were 3.545, 0.438, and 0.178.

Table 4. Between groups F-matrix for the four a priori group analysis (df = 8, 7, 204).

Group	*chilensis*	*juliae*	*pringlei*
juliae	6.946		
pringlei	8.930	3.067	
tortifolia	24.110	4.047	7.556

Wilks' lambda = 01021 df = 14 3 118
Approx. F= 8.6018 df = 42 312 prob = 0.0000

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of four a priori groups; a posteriori placements to groups in rows.

Group	*chilensis*	*juliae*	*pringlei*	*tortifolia*	% correct
chilensis	79	3	2	0	94
juliae	0	11	0	0	100
pringlei	0	1	11	0	92
tortifolia	0	1	0	14	93
Totals	79	16	13	14	94

Jackknifed classification matrix

Group	*chilensis*	*juliae*	*pringlei*	*tortifolia*	% correct
chilensis	78	4	2	0	93
juliae	0	9	2	0	82
pringlei	1	3	8	0	67
tortifolia	0	2	0	13	87
Totals	79	18	12	13	89

DISCUSSION

The results of the multivariate analyses support the recognition of *Solidago altiplanities*, *S. chilensis*, *S. gypsophila*, *S. juliae*, *S. leavenworthii*, *S. microglossa*, *S. pringlei*, and *S. tortifolia* as separate species and *S. altissima* var. *gilvocanescens* as a separate taxon. Because a single specimen cannot be treated as an a priori group in discriminant analyses, the single specimen of *S. gypsophila* was not assigned to an a priori group but was included in the a posteriori classificatory discriminant analyses, which assigned a posteriori the specimen in the eight-species analysis to *S. altissima* var. *gilvocanescens* with 73% probability (21% to *S. juliae*, 6% to *S. tortifolia*) and in the four-species analysis to *S. juliae* with 95% probability. In both analyses, involucre height and numbers of ray florets were the two most important traits in separating the a priori groups, with the two traits switching first and second position in importance in the two analyses.

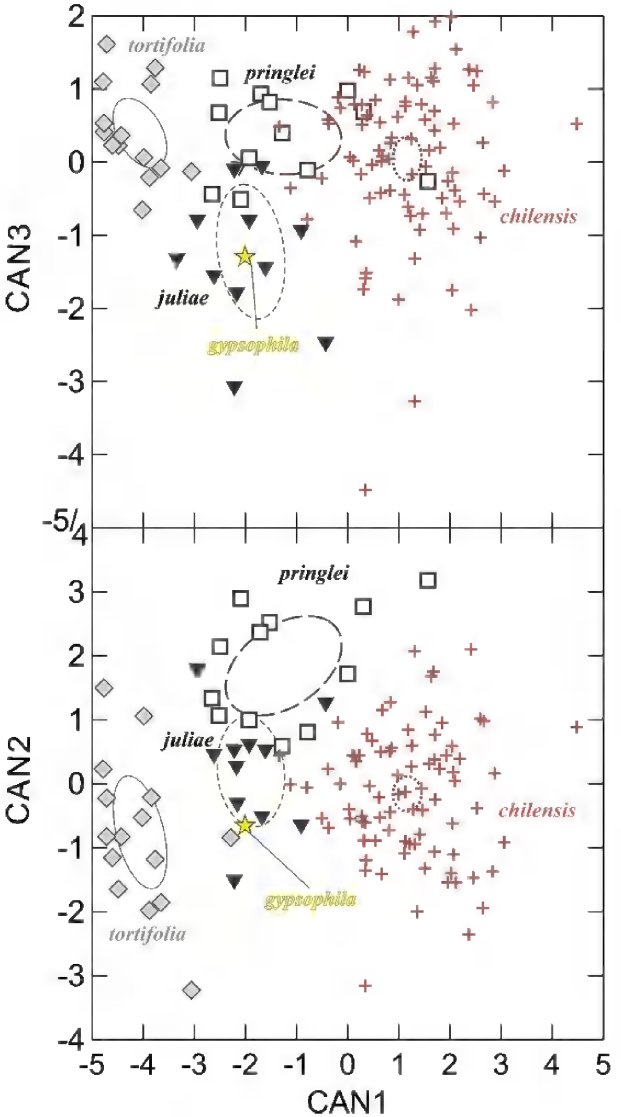

Figure 11. Plots of CAN1 versus CAN3 and CAN1 versus CAN2 of 119 specimens of *Solidago chilensis* (brown +), *S. juliae* (black triangles), *S. pringlei* (white squares with black outlines), and *S. tortifolia* (gray diamonds with black outlines), and the one collection of *S. gypsophila* (yellow stars); 95% confidence ellipses are included.

The results support Nesom's (1989a) observation that *Solidago gypsophila* is similar to *S. juliae* (treated in that paper as *S. canadensis* var. *canescens*) and the initial observation of the first author of this paper that *S. gypsophila* was similar in some ways to *S. altissima* var. *gilvocanescens*. The broad middle

and inner phyllaries of *S. gypsophila* separate the species from both *S. juliae* and *S. altissima*, although the trait was not selected by STEPDISC as significant in separating a priori groups in both the eight- and four-taxa analyses. The holotype of *S. gypsophila* has a very robust long branched inflorescence, while the nearly flowering paratype illustrated in Fig. 5 has smaller and short branched inflorescences that are like those of most specimens of the *Tortifolia* Group, i.e., long and narrow secund-conical inflorescences, which is a more accurate description than the often used "secund-pyramidal" description.

This is the first multivariate analysis that has included *Solidago pringlei* and all eight of the core informal *Tortifolia* group of species in subsect. *Triplinerviae*. Lopez Laphitz (2009) and Lopez Laphitz and Semple included six of the species in the analyses focusing on the two South American species *S. chilensis* and *S. microglossa*. Semple et al. (2015) included *S. altiplanities* and *S. juliae* in their analysis of *S. altissima* and *S. canadensis* varieties. The results of both the eight-species analysis and the four-species analysis of this paper demonstrate that the northeastern Mexican endemic *S. pringlei* is central to the *Tortifolia* group of species because it includes variation in traits that are useful in defining other species. Lower stem pubescence varies from typical-for-the-group very short densely villose-canescent indument to glabrous, which occurs generally in *S. chilensis* from Chile and central and southern Argentina. Broader phyllaries are typical in *S. leavenworthii* and occur in some *S. chilensis*, both of which have taller involucres, but they are most pronounced in *S. gypsophila* because it has shorter involuces and shorter phyllaries. Of note, some specimens of *S. pringlei* were assigned to *S. chilensis* in the eight- species analysis. The first author's initial impression of the loan of specimens from TEX was that there might be two separate taxa in the stack of 10 specimens. Preliminary results did not support this, and all collections were treated as belonging in a variable *S. pringlei* that included some specimens that were rather *S. chilensis*-like. The GH holotype of *S. pringlei* was placed a posteriori into *S. pringlei* (95% and 97% probabilities). In both analyses, the GH isotype of *S. muelleri* was placed a posteriori into *S. juliae* with 61% probability (27% to *S. pringlei*, 8% to *S. tortifolia*) in the eight-species analysis and 53% (42% to *S. pringlei*, 5% to *S. tortifolia*) in the four-species analysis. However, on the basis of stem pubescence it does not belong in that species and does look overall similar to some specimens of *S. pringlei* that were included in the species a posteriori. Based on the holotype and the isotypes, *S. muelleri* should be treated as a synonym of *S. pringlei*.

Solidago pringlei is a likely candidate for the species that was long-distance dispersed from northern Mexico to Bolivia, where it diverged and evolved into *S. chilensis* and *S. microglossa*. The alternative to this interpretation is that *S. chilensis* was introduced into Nuevo León, Mexico, in post Columbian times and persisted long enough to hybridize with *S. pringlei* at some locations to add more *S. chilensis*-like features to some *S. pringlei*, but never became well established as it has in the West Indies and other locations. Parsimony favors the idea that *S. pringlei* is simply rather variable in stem indument and phyllary traits.

The known chromosome numbers for *Solidago altiplanities*, *S. chilensis*, *S. microglossa*, and *S. tortifolia* are all diploid, $2n$=18. *Solidago leavenworthii* includes tetraploids and hexaploids. The chromosome numbers of *S. gypsophila* and *S. pringlei* are unknown.

The eight species analysis does not provide evidence that *Solidago altissima* var. *gilvocanescens* is a member of the *Tortifolia* group of species of subsect. *Triplinerviae,* which generally have narrow lanceolate to linear lanceolate leaves and narrow elongated secund conical inflorescences. A multivariate analysis of all species of subsect. *Triplinerviae* is needed. In the eight-species analysis presented here, *S. altissima* var. *gilvocanescens* was most distant from *S. chilensis* and *S. microglossa* but not close to *S. juliae*, as indicated by Mahalanobis distances and the accompanying F-to-separate values. A molecular phylogeny of all species in the genus with data sufficient to resolve relationships of closely related species is very much needed. Multivariate analysis is not a method suited for determining phylogenetic relationships, although it can reveal morphological similarities previously overlooked.

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THE NATIONAL WETLAND PLANT LIST: 2016 WETLAND RATINGS

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ABSTRACT

The U.S. Army Corps of Engineers (Corps) administers the National Wetland Plant List (NWPL) for the United States (U.S.) and its territories. Responsibility for the NWPL was transferred to the Corps from the U.S. Fish and Wildlife Service (FWS) in 2006. From 2006 to 2012 the Corps led an interagency effort to update the list in conjunction with the U.S. Environmental Protection Agency (EPA), the FWS, and the USDA Natural Resources Conservation Service (NRCS), culminating in the publication of the 2012 NWPL. In 2013 and 2014 geographic ranges and nomenclature were updated. This paper presents the fourth update of the list under Corps administration. During the current update, the indicator status of 1689 species was reviewed. A total of 306 ratings of 186 species were changed during the update. The changes were to decrease rating variability nationally, in response to user requests, and to include a re-evaluation South Pacific Island species. The 2012 list included 7828 species, the 2013 update included 7937 species, and the 2014 update included 8057. The 2016 NWPL includes 8092 species. As part of the authorization of the revised 2016 NWPL, all future changes must be vetted in the Federal Register according to a new schedule for biannual updates.

Since the Corps assumed administrative responsibilities for the National Wetland Plant List (NWPL) in 2006, the list has gone through an extensive updating process that culminated in its authorization for national use in May 2012 (Federal Register 2012; Lichvar 2012). The development of the 2012 list was a cooperative effort between four federal government agencies: the Corps, the EPA, the FWS, and the NRCS. The effort was managed by a National Panel (NP) consisting of representatives from the four agencies. The NWPL is the standard reference for wetland indicator status ratings of vascular plants in the United States and territories, and is used for many purposes, including wetland delineation, assessment, mitigation, and habitat restoration. The NWPL is available to all users through a web application (http://wetland_plants.usace.army.mil/). The 2012

update built on the legacy of the FWS's 1988 (Reed 1988), 1993 Region 9 (Northwest) Supplement (Reed 1993), and draft 1996 wetland plant lists. It updated all taxonomic views and nomenclature in accordance with Biota North America Program (BONAP) and revised wetland ratings (Lichvar & Minkin 2008). Additionally, the 2012 revision included several changes to the management of the NWPL, along with revised definitions of wetland categories, new Corps geographic wetland regions, protocols for challenging wetland ratings, and procedures for annual revisions.

As with previous versions of the wetland plant list, the 2012 NWPL and updates support wetland delineation efforts under Sec. 404 of the Clean Water Act, the Swampbuster provisions of the Farm Bill (as amended), and the National Wetland Inventory Program. To accomplish this more effectively, the Corps realigned the NWPL's geographic regions to correspond to those of federal wetland efforts, including the interagency wetland delineation manual and its regional wetland delineation supplements. The NWPL is divided using the 10 regional Corps wetland delineation regions for the U.S. and its territories (Wakeley 2002) (Appendices A – C). Included within four of these Corps regions are 17 subregions in which small numbers of wetland plants have wetland ratings that differ from the ratings for the same plants in the rest of the region. For example, *Aralia spinosa* L. is rated FACU in the Western Gulf Coast subregion and FAC in the rest of the Atlantic and Gulf Coastal Plain region.

The five wetland rating categories in the NWPL were developed in the 1980s by Reed (1988). Each plant species was assigned a rating representing the estimated probability, or frequency, with which it was thought to occur in wetlands, as opposed to non-wetlands, across its entire range. The 1988 ratings were divided into categories based on quantitative ranges of frequency, but the 2012 ratings were based on simpler qualitative definitions (Table 1) (Lichvar et al. 2012). Regional panel (RP) and NP members from the four cooperating Federal agencies use their best professional judgment to assign indicator status ratings to each species based on a review of the botanical literature and herbarium records, and field experiences. Quantitative rating definitions are still used, but only for field testing of wetland ratings.

Table 1. Short qualitative descriptions of the five wetland indicator status ratings used to determine if vegetation is hydrophytic during wetland delineations in the United States.

Indicator status	**Designation**	**Qualitative Description** (Lichvar et al. 2012)
Obligate (OBL)	Hydrophyte	Almost always occur in wetland.
Facultative Wetland (FACW)	Hydrophyte	Usually occur in wetland, but may occur in nonwetland.
Facultative (FAC)	Hydrophyte	Occur in wetland and nonwetland.
Facultative Upland (FACU)	Nonhydrophyte	Usually occur in non-wetland, but may occur in wetland.
Upland (UPL)	Nonhydrophyte	Almost never occur in wetland.

Annual Update Process

As part of the 2016 NWPL update, representatives from each of the four Federal agencies responsible for the NWPL agreed on a standardized schedule for managing the list, described in the Final announcement of the NWPL update (Federal Register, 2016). Under the 2016 NWPL authorization, all NWPL updates must be vetted in the Federal Register. In particular, NWPL updates include additions or deletions to the list; modifications to wetland indicator statuses; and updates of the nomenclature, taxonomy, habitat citations from the literature, and geographic distributions of species on the NWPL.

Biennial NWPL updates will ensure that nomenclature and taxonomy do not become outdated and wetland ratings can be refined as new information becomes available. Updates will occur according to the following procedures. A change in indicator status may be requested at any time at *http:// wetland_plants.usace.army.mil/* by clicking on the "Submit a NWPL Change Request" link and submitting the appropriate data. Data includes ecological or geographic data, literature reviews, testing descriptions, and frequency and abundance data for the taxon in wetlands and uplands in the Corps wetland region or subregion for which the change is proposed. The regions and subregions are based on Land Resource Regions (LRRs) and Major Land Resource Areas (MLRAs) (*http:// soils.usda.gov/survey/ geography/ mlra/*) and are shown for each wetland supplement region on the NWPL Web site. If the commenter feels that a wetland supplement region needs a subregion that has not yet been developed, the commenter should identify the MLRAs involved and provide a list of species from within that region that need their own wetland ratings. Proposed rating changes will be compiled in January of odd years (i.e., 2017, 2019) and sent to the RPs for input in February. The NP will assign wetland ratings to non-consensus species and will review all regional lists in April. The proposed changes will be compiled over the summer and published in the Federal Register for public comment in September. In October, public comments will be summarized and the NP will review and respond to comments. The final changes will be published in the Federal Register in December of odd years.

The 2016 NWPL Update

The 2012 NWPL contained 7828 species and the 2013 NWPL contained 7937 wetland plants for the United States and its territories. Newly suggested additions to the list and geographic range extensions increased the 2014 NWPL to 8061 wetland plants. Four species were removed from the list as they were determined to be rated UPL in all regions in which they occur, reducing the total species on the 2014 NWPL to 8057. There are 8053 species on the 2016 NWPL (± 127 in the SPI) (Federal Register 2016). No nomenclatural changes were made during the 2016 NWPL update. As with the 2014 list, nomenclature is according to BONAP (Kartesz 2013). Geographic updates for six new species are according to PLANTS database (USDA, NRCS 2016). Species with rating changes are shown in Appendix D.

The review process for the 2016 NWPL update began in 2015 and included review by RPs, the NP, and the public, who provided input on changes to the wetland indicator status of 189 species. Four groups of species were examined during this update. The first group consisted of rating changes for 25 species (including six new additions) that the public requested on the NWPL website (November 10, 2014 to January 31, 2015) and during the Federal Register Comment Period of September 14, 2015 to November 13, 2015 (Federal Register 2015). The second group consisted of 166 species with highly variable ratings that spanned more than three ratings categories, nationally (e.g., rated FACW in the Arid West and UPL in the Caribbean). The third group consisted of five nationally problematic species. Initially, the public requested a rating change for these five species in one region. However, their ratings were reexamined in all regions where they occur, based on NP requests. Seven species occurred in more than one of these three groups. The fourth group consisted of input received on the wetland ratings of species in the South Pacific Islands (SPI) subregion.

This update contains 8092 species, an increase of 35 species from the 2014 NWPL. Ten species rated UPL in all regions were dropped from the list, six new species were added in the continental U.S, and 39 new species were added in the SPI subregion. The new list includes changes in plant indicator status (OBL, FACW, FAC, FACU, and UPL designations) from 2014 for 186 species in the continental U.S. There were a total of 306 rating changes since these 186 species can occur in multiple Corps delineation regions, each having a unique indicator status rating. The specifics of the 306 rating changes were as follows: 49 percent (115 species) were given wetter indicator ratings, and 51 percent (112 species) were given drier indicator ratings (ratings of 41 species went wetter in one region and drier in another). The additional rating changes for 189 species in the SPI subregion bring the total rating changes to 1.8% of the NWPL.

ACKNOWLEDGEMENTS

Many people, agencies and organizations are involved in maintaining and improving the accuracy of the NWPL, and they are all thanked for their support and input. The bulk of the effort and thanks goes to the National and Regional Panel members across the country who dedicate significant time and energy responding to requests to evaluate endless lists of wetland plants. Many people in the public sector have made valuable suggestions and input about wetland species. Underlying these efforts is the work of several key people, who are thanked: John Kartesz and Misako Nishino, at BONAP, who compiled the data and Rick Bates and Jennifer Gillrich, who manage to keep millions of data points in the right places –– making it all happen. We thank the Wetland Regulatory Assistance Program of the U.S. Army Corps of Engineers for funding these efforts.

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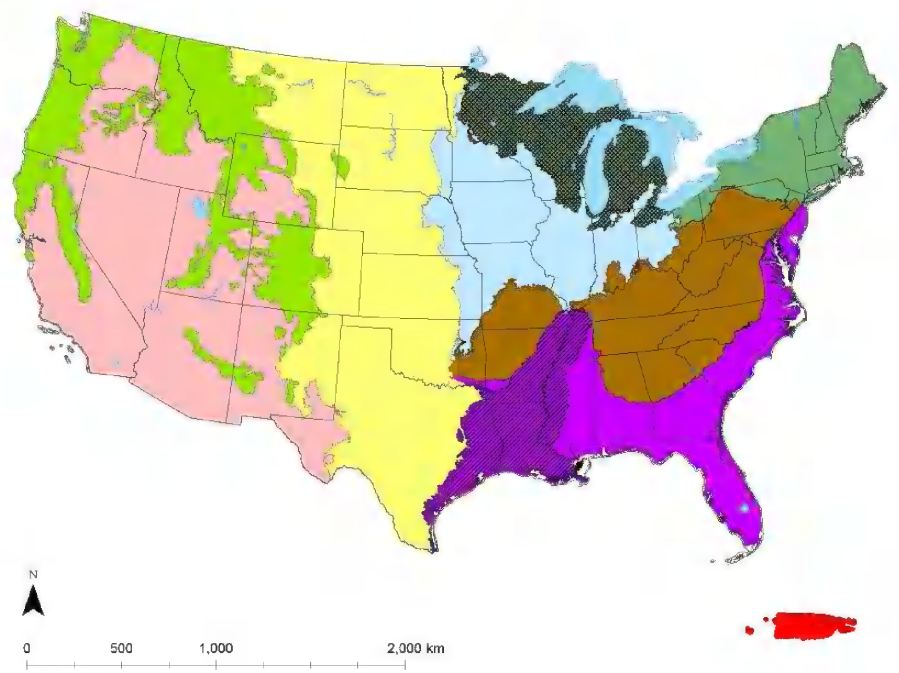
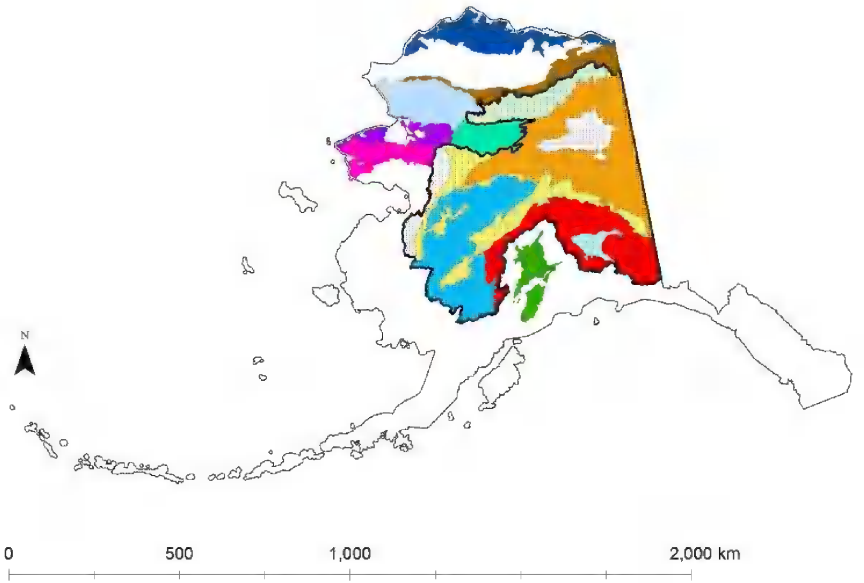
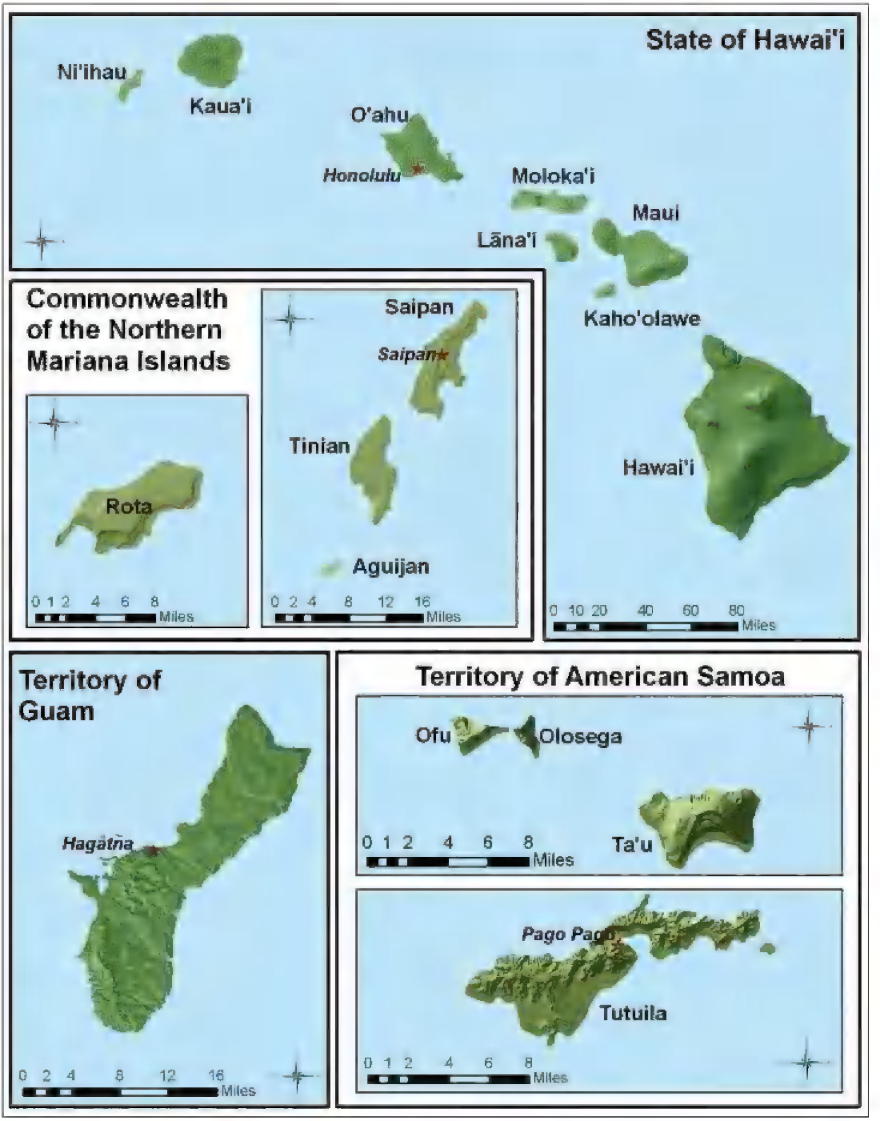
Appendix A. Eight of the ten Corps Regions. Two subregions are shown, the Western Gulf Coast subregion of the Atlantic and Gulf Coast Plain Region and the Northcentral Great Lakes subregion of the Northcentral and Northeast region. The Caribbean Region is not drawn to scale. The Hawaii and Alaska regions are shown in Appendices B and C.



Appendix B. The Alaska region and its fourteen subregions.



Appendix C. The Hawaii Region and the South Pacific Island Subregion.



Appendix D. List of rating changes for species on the National Wetland Plant List (NWPL) from 2014 to 2016. The Corps wetland regions, shown in Appendices A–C, are abbreviated: Atlantic and Gulf Coastal Plain (AGCP), Alaska (AK), Arid West (AW), Caribbean Islands (CB), Eastern Mountains and Piedmont (EMP), Great Plains (GP), Hawaii and Pacific Islands (HI), Midwest (MW), Northcentral and Northeast (NCNE), and Western Mountains, Valleys and Coast (WMVC). Subregions are abbreviated: Interior Alaska Lowlands (AK-IAL), Cook Inlet Lowlands subregion (AK-CIL), and South Pacific Islands (SPI).

Reason	Region	Scientific Name	2014	2016	Common Name
HVR	AGCP	*Aristida purpurascens*	FACW	UPL	Arrow-Feather Three-Awn
HVR	AGCP	*Asemeia grandiflora*	OBL	UPL	Violet Fringeless-Milkwort
HVR	AGCP	*Asplenium dentatum*	FACW	FACU	Toothed Spleenwort
HVR	AGCP	*Baccharis dioica*	FACW	FAC	Broombush False Willow
HVR	AGCP	*Canna indica*	OBL	FACW	Indian-Shot
HVR	AGCP	*Canna X generalis*	FACU	FACW	
HVR	AGCP	*Carex brevior*	OBL	FAC	Short-Beak Sedge
HVR	AGCP	*Carex willdenowii*	FACW	FACU	Willdenow's Sedge
HVR	AGCP	*Crossopetalum rhacoma*	FACW	FACU	Maiden-Berry
HVR	AGCP	*Crypsis schoenoides*	FACU	FACW	Swamp Prickle Grass
HVR	AGCP	*Cuphea carthagenensis*	FACW	FAC	Colombian Waxweed
HVR	AGCP	*Cuphea hyssopifolia*	FAC	FACU	False Heather
HVR	AGCP	*Cynophalla flexuosa*	FACW	UPL	Falseteeth
HVR	AGCP	*Dieffenbachia seguine*	UPL	FACU	Dumb-Cane
HVR	AGCP	*Elionurus tripsacoides*	FACW	FAC	Pan-American Balsamscale
HVR	AGCP	*Eltroplectris calcarata*	OBL	FAC	Long-Claw Orchid
HVR	AGCP	*Evolvulus sericeus*	FACW	FACU	Silver Dwarf-Morning-Glory
HVR	AGCP	*Hainardia cylindrica*	UPL	FACW	Barb Grass
HVR	AGCP	*Hemarthria altissima*	FAC	FACW	Limpo Grass
HVR	AGCP	*Hymenocallis latifolia*	OBL	FACW	Perfumed Spider-Lily
HVR	AGCP	*Ipomoea hederifolia*	FACW	FACU	Scarlet-Creeper
HVR	AGCP	*Leersia monandra*	FACW	UPL	Bunch Cut Grass
HVR	AGCP	*Mazus pumilus*	FAC	FACU	Japanese Mazus
HVR	AGCP	*Minuartia glabra*	FACW	UPL	Appalachian Stitchwort
HVR	AGCP	*Muhlenbergia sericea*	OBL	FACW	Slender Muhly
HVR	AGCP	*Nama jamaicense*	UPL	FACU	Jamaican-Weed
HVR	AGCP	*Pecluma ptilodon*	FACW	FAC	Palm-Leaf Rockcap Fern
HVR	AGCP	*Pentalinon luteum*	OBL	FAC	Hammock Viper's-Tail
HVR	AGCP	*Persicaria posumbu*	FACW	FACU	Oriental Lady's-Thumb
HVR	AGCP	*Petasites hybridus*	UPL	FAC	Pestilence-Wort
HVR	AGCP	*Philodendron hederaceum*	UPL	FACU	Vilevine
HVR	AGCP	*Physaria gracilis*	FACW	UPL	Spreading Bladderpod
HVR	AGCP	*Piper aduncum*	FACW	FAC	Spiked Pepper
HVR	AGCP	*Plantago coronopus*	UPL	FACU	Buck-Horn Plantain
HVR	AGCP	*Poa alsodes*	UPL	FACU	Grove Blue Grass
HVR	AGCP	*Polygonum patulum*	UPL	FAC	Bellard's Knotweed
HVR	AGCP	*Polypogon viridis*	OBL	FACW	Beardless Rabbit's-Foot Grass
HVR	AGCP	*Pycnanthemum verticillatum*	UPL	FAC	Whorled Mountain-Mint
HVR	AGCP	*Scleria lithosperma*	FACW	FAC	Florida Keys Nut-Rush
HVR	AGCP	*Solidago X asperula*	UPL	FACU	
HVR	AGCP	*Spiraea douglasii*	UPL	FAC	Douglas' Meadowsweet
HVR	AGCP	*Strumpfia maritima*	OBL	FAC	Pride-of-Big-Pine
HVR	AGCP	*Symphyotrichum pilosum*	FACW	FAC	White Oldfield American-Aster
HVR	AGCP	*Tectaria fimbriata*	OBL	FACW	Fringed Halberd Fern
HVR	AGCP	*Tectaria heracleifolia*	FACW	FACU	Broad Halberd Fern

Reason	Region	Scientific Name	2014	2016	Common Name
HVR	AGCP	*Teucrium cubense*	UPL	FACW	Small Coastal Germander
HVR	AGCP	*Thelypteris ovata*	UPL	FACW	Ovate Marsh Fern
HVR	AGCP	*Thuja occidentalis*	UPL	FACW	Eastern Arborvitae
HVR	AGCP	*Trichomanes holopterum*	OBL	RST	Entire-Wing Bristle Fern
HVR	AGCP	*Triphora trianthophoros*	FACW	FACU	Threebirds
HVR	AGCP	*Urochloa arrecta*	UPL	FAC	African Liverseed Grass
HVR	AGCP	*Vanilla barbellata*	FACW	FACU	Wormvine Orchid
HVR	AGCP	*Zingiber zerumbet*	UPL	FAC	Shampoo Ginger
NPR	AGCP	*Andropogon gyrans*	FAC	FACU	Elliott's Bluestem
NPR	AGCP	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	AGCP	*Parapholis incurva*	FAC	FACU	Curved Sickle Grass
PR	AGCP	*Pinus palustris*	FAC	FACU	Long-Leaf Pine
HVR	AK	*Atriplex hortensis*	FACW	FACU	Garden Orache
HVR	AK	*Erigeron glabellus*	UPL	FACU	Streamside Fleabane
HVR	AK	*Honckenya peploides*	OBL	FACU	Seaside Sandplant
HVR	AK	*Ribes glandulosum*	FACU	FAC	Skunk Currant
HVR	AK	*Ribes oxyacanthoides*	UPL	FACU	Canadian Gooseberry
HVR	AK	*Salix X sepulcralis*	FACW	FAC	
HVR	AK	*Saxifraga adscendens*	UPL	FACU	Wedge-Leaf Saxifrage
HVR	AK	*Senecio eremophilus*	UPL	FACU	Desert Ragwort
HVR	AK	*Sidalcea hendersonii*	UPL	FACU	Henderson's Checkerbloom
HVR	AK	*Silene uralensis*	UPL	FAC	Apetalous Catchfly
HVR	AK	*Stachys mexicana*	UPL	FACU	Mexican Hedge-Nettle
HVR	AK	*Triantha occidentalis*	UPL	FACW	Western False Asphodel
HVR	AK	*Veronica peregrina*	FACW	FACU	Neckweed
PR	AK	*Betula kenaica*	----	FACU	Kenai Birch
PR	AK-CIL	*Betula kenaica*	----	FACU	Kenai Birch
PR	AK-CIL	*Betula papyrifera*	FAC	FACU	Paper Birch
PR	AK-IAL	*Betula kenaica*	----	FACU	Kenai Birch
PR	AK-IAL	*Betula papyrifera*	FAC	FACU	Paper Birch
HVR	AW	*Amaranthus blitoides*	FACW	FACU	Mat Amaranth
HVR	AW	*Ampelopsis arborea*	FACU	FAC	Peppervine
HVR	AW	*Crypsis schoenoides*	OBL	FACW	Swamp Prickle Grass
HVR	AW	*Echinochloa esculenta*	UPL	FACU	Japanese Water Grass
HVR	AW	*Elionurus tripsacoides*	UPL	FAC	Pan-American Balsamscale
HVR	AW	*Mazus pumilus*	FACW	FACU	Japanese Mazus
HVR	AW	*Mentha spicata*	OBL	FACW	Spearmint
HVR	AW	*Miscanthus sinensis*	FACW	FACU	Chinese Silver Grass
HVR	AW	*Myosotis discolor*	FACW	FAC	Yellow Scorpion-Grass
HVR	AW	*Myosotis sylvatica*	FAC	FACU	Woodland Forget-Me-Not
HVR	AW	*Physaria gracilis*	FACW	UPL	Spreading Bladderpod
HVR	AW	*Plantago coronopus*	FACW	FAC	Buck-Horn Plantain
HVR	AW	*Pteris vittata*	FACW	FAC	Ladder Brake
HVR	AW	*Ranunculus bulbosus*	FACW	FAC	St. Anthony's-Turnip
HVR	AW	*Silene hitchguirei*	OBL	UPL	Mountain Catchfly
HVR	AW	*Symphytum asperum*	FACW	FAC	Prickly Comfrey
HVR	AW	*Tamarix gallica*	FACW	FAC	French Tamarisk
HVR	AW	*Triantha occidentalis*	UPL	FACW	Western False Asphodel
HVR	AW	*Veronica peregrina*	OBL	FAC	Neckweed
HVR	AW	*Vulpia bromoides*	FAC	FACU	Brome Six-Weeks Grass
HVR	AW	*Washingtonia filifera*	FACW	FAC	California Fan Palm

Reason	Region	Scientific Name	2014	2016	Common Name
PR	AW	*Astragalus diversifolius*	----	FAC	Meadow Milkvetch
PR	AW	*Atriplex torreyi*	FAC	FACU	Torrey's Saltbush
PR	AW	*Bassia hyssopifolia*	FAC	FACU	Five-Horn Smotherweed
PR	AW	*Chilopsis linearis*	FACU	FAC	Desert-Willow
PR	AW	*Danthonia californica*	FACU	FAC	California Wild Oat Grass
PR	AW	*Helminthotheca echioides*	FACU	FAC	Akan Asante
PR	AW	*Leymus simplex*	----	FAC	Alkali Lyme Grass
PR	AW	*Parapholis incurva*	FAC	FACU	Curved Sickle Grass
PR	AW	*Poa annua*	FACU	FAC	Annual Blue Grass
PR	AW	*Polygonum aviculare*	FACW	FAC	Yard Knotweed
PR	AW	*Prosopis glandulosa*	UPL	FACU	Honey Mesquite
PR	AW	*Rubus armeniacus*	FACU	FAC	Himalayan Blackberry
PR	AW	*Sarcobatus vermiculatus*	FAC	FACU	Greasewood
PR	AW	*Trifolium fragiferum*	FACU	FAC	Strawberry-Head Clover
HVR	CB	*Aeschynomene indica*	UPL	FACW	Indian Joint-Vetch
HVR	CB	*Ampelopsis arborea*	UPL	FAC	Peppervine
HVR	CB	*Asemeia grandiflora*	FAC	UPL	Violet Fringeless-Milkwort
HVR	CB	*Cakile lanceolata*	UPL	FAC	Coastal Searocket
HVR	CB	*Carex longii*	UPL	FACW	Long's Sedge
HVR	CB	*Christella dentata*	UPL	FACU	Pai'i'iho
HVR	CB	*Citharexylum caudatum*	FACW	FACU	Juniper-Berry
HVR	CB	*Cranichis muscosa*	FACW	FACU	Cypress-Knee Helmet Orchid
HVR	CB	*Crocosmia X crocosmiiflora*	UPL	FACU	
HVR	CB	*Cuphea carthagenensis*	UPL	FAC	Colombian Waxweed
HVR	CB	*Cuphea hyssopifolia*	UPL	FACU	False Heather
HVR	CB	*Dieffenbachia seguine*	FACW	FAC	Dumb-Cane
HVR	CB	*Dinebra panicoides*	UPL	FACW	Amazon Viper Grass
HVR	CB	*Dioscorea villosa*	UPL	FAC	Wild Yam
HVR	CB	*Eleocharis radicans*	UPL	OBL	Rooted Spike-Rush
HVR	CB	*Funastrum clausum*	OBL	FACW	White Twinevine
HVR	CB	*Huperzia lucidula*	UPL	FAC	Shining Fir-Moss
HVR	CB	*Hymenocallis latifolia*	UPL	FACW	Perfumed Spider-Lily
HVR	CB	*Ilex cassine*	UPL	FACW	Dahoon
HVR	CB	*Ipomoea hederifolia*	FAC	FACU	Scarlet-Creeper
HVR	CB	*Ludwigia repens*	UPL	OBL	Creeping Primrose-Willow
HVR	CB	*Lygodium japonicum*	UPL	FACU	Japanese Climbing Fern
HVR	CB	*Muhlenbergia capillaris*	OBL	FAC	Hair-Awn Muhly
HVR	CB	*Nama jamaicense*	UPL	FACU	Jamaican-Weed
HVR	CB	*Odontosoria clavata*	FACW	UPL	Club-Shape Parsley Fern
HVR	CB	*Panicum dichotomiflorum*	OBL	FAC	Fall Panic Grass
HVR	CB	*Paspalum boscianum*	UPL	FAC	Bull Crown Grass
HVR	CB	*Pentalinon luteum*	FACU	FAC	Hammock Viper's-Tail
HVR	CB	*Persicaria robustior*	UPL	OBL	Stout Smartweed
HVR	CB	*Philodendron hederaceum*	FACW	FACU	Vilevine
HVR	CB	*Piper aduncum*	FACW	FAC	Spiked Pepper
HVR	CB	*Plantago lanceolata*	FACW	FACU	English Plantain
HVR	CB	*Poa annua*	OBL	FACU	Annual Blue Grass
HVR	CB	*Poa pratensis*	OBL	FACU	Kentucky Blue Grass
HVR	CB	*Psilotum nudum*	UPL	FACU	Whisk Fern
HVR	CB	*Pteris tripartita*	UPL	FACU	Giant Brake
HVR	CB	*Salix X sepulcralis*	UPL	FACU	

Reason	Region	Scientific Name	2014	2016	Common Name
HVR	CB	*Sambucus nigra*	UPL	FAC	Black Elder
HVR	CB	*Samolus parviflorus*	FACU	OBL	
HVR	CB	*Sauvagesia erecta*	FACW	FACU	Creole-Tea
HVR	CB	*Scleria brittonii*	UPL	FACW	Britton's Nut-Rush
HVR	CB	*Solanum campechiense*	OBL	FACU	Red-Berry Nightshade
HVR	CB	*Solidago sempervirens*	UPL	FACU	Seaside Goldenrod
HVR	CB	*Spartina patens*	FACU	FACW	Salt-Meadow Cord Grass
HVR	CB	*Sporobolus pyramidatus*	FACW	FAC	Target Dropseed
HVR	CB	*Tamarix aphylla*	UPL	FACW	Athel Tamarisk
HVR	CB	*Tamarix gallica*	UPL	FAC	French Tamarisk
HVR	CB	*Tectaria fimbriata*	UPL	FACW	Fringed Halberd Fern
HVR	CB	*Trichomanes holopterum*	UPL	RST	Entire-Wing Bristle Fern
HVR	CB	*Urochloa arrecta*	FACW	FAC	African Liverseed Grass
HVR	CB	*Vanilla barbellata*	UPL	FACU	Wormvine Orchid
HVR	CB	*Washingtonia filifera*	UPL	FACU	California Fan Palm
HVR	CB	*Zingiber zerumbet*	FACW	FAC	Shampoo Ginger
HVR	EMP	*Alternanthera sessilis*	FACU	FAC	Sessile Joyweed
HVR	EMP	*Andropogon gyrans*	OBL	FACU	Elliott's Bluestem
HVR	EMP	*Asemeia grandiflora*	FACU	UPL	Violet Fringeless-Milkwort
HVR	EMP	*Atriplex hortensis*	UPL	FAC	Garden Orache
HVR	EMP	*Cardamine flexuosa*	OBL	FAC	Woodland Bittercress
HVR	EMP	*Carex brevior*	UPL	FAC	Short-Beak Sedge
HVR	EMP	*Carex caroliniana*	FACU	FACW	Carolina Sedge
HVR	EMP	*Carex normalis*	FACU	FACW	Greater Straw Sedge
HVR	EMP	*Carex praegracilis*	UPL	FACW	Clustered Field Sedge
HVR	EMP	*Chaerophyllum tainturieri*	FACW	FAC	Hairy-Fruit Chervil
HVR	EMP	*Crypsis schoenoides*	FACU	FACW	Swamp Prickle Grass
HVR	EMP	*Cuphea carthagenensis*	FACW	FAC	Colombian Waxweed
HVR	EMP	*Echinochloa esculenta*	UPL	FACU	Japanese Water Grass
HVR	EMP	*Elionurus tripsacoides*	FACW	FAC	Pan-American Balsamscale
HVR	EMP	*Macrothelypteris torresiana*	OBL	FAC	False Maiden Fern
HVR	EMP	*Petasites hybridus*	UPL	FAC	Pestilence-Wort
HVR	EMP	*Plantago coronopus*	UPL	FACU	Buck-Horn Plantain
HVR	EMP	*Polygonum patulum*	UPL	FAC	Bellard's Knotweed
HVR	EMP	*Pycnanthemum muticum*	FACW	FAC	Clustered Mountain-Mint
HVR	EMP	*Ranunculus sardous*	UPL	FAC	Hairy Buttercup
HVR	EMP	*Sinapis alba*	FACW	FAC	White-Mustard
HVR	EMP	*Spiraea douglasii*	UPL	FAC	Douglas' Meadowsweet
HVR	EMP	*Tamarix parviflora*	UPL	FAC	Small-Flower Tamarisk
HVR	EMP	*Thalictrum revolutum*	UPL	FAC	Waxy-Leaf Meadow-Rue
HVR	EMP	*Thelypteris ovata*	UPL	FACW	Ovate Marsh Fern
HVR	EMP	*Trianthema portulacastrum*	UPL	FAC	Desert Horse-Purslane
HVR	EMP	*Vulpia bromoides*	FACW	FACU	Brome Six-Weeks Grass
NPR	EMP	*Asclepias sullivantii*	----	FAC	Prairie Milkweed
NPR	EMP	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	EMP	*Parapholis incurva*	OBL	FACU	Curved Sickle Grass
PR	EMP	*Ranunculus bulbosus*	UPL	FAC	St. Anthony's-Turnip
HVR	GP	*Ambrosia monogyra*	FACW	FACU	Needle-Leaf Burrobush
HVR	GP	*Carex cephalophora*	OBL	FACU	Oval-Leaf Sedge
HVR	GP	*Carex complanata*	OBL	FAC	Hirsute Sedge
HVR	GP	*Crassula solieri*	FACU	FACW	Smooth-Seed Pygmyweed

Reason	Region	Scientific Name	2014	2016	Common Name
HVR	GP	*Cuphea carthagenensis*	FACW	FAC	Colombian Waxweed
HVR	GP	*Echinochloa esculenta*	UPL	FACU	Japanese Water Grass
HVR	GP	*Elionurus tripsacoides*	UPL	FACU	Pan-American Balsamscale
HVR	GP	*Euphorbia serpens*	UPL	FACU	Matted Sandmat
HVR	GP	*Funastrum clausum*	FACU	FACW	White Twinevine
HVR	GP	*Leersia monandra*	FACW	UPL	Bunch Cut Grass
HVR	GP	*Lysimachia arvensis*	FACW	FACU	Scarlet Yellow-Loosestrife
HVR	GP	*Myosotis sylvatica*	FACW	FACU	Woodland Forget-Me-Not
HVR	GP	*Neottia banksiana*	OBL	FACU	Northwestern Twayblade
HVR	GP	*Parkinsonia aculeata*	FACW	FAC	Mexican Palo-Verde
HVR	GP	*Phragmites karka*	FACU	FACW	Tropical Reed
HVR	GP	*Physaria gracilis*	FACW	UPL	Spreading Bladderpod
HVR	GP	*Polypogon viridis*	OBL	FACW	Beardless Rabbit's-Foot Grass
HVR	GP	*Saccharum brevibarbe*	UPL	FACW	Short-Beard Plume Grass
HVR	GP	*Senecio crassulus*	OBL	FACU	Thick-Leaf Ragwort
HVR	GP	*Stellaria longipes*	OBL	FACW	Long-Stalk Starwort
HVR	GP	*Tectaria heracleifolia*	FACW	FACU	Broad Halberd Fern
HVR	GP	*Triantha occidentalis*	UPL	FACW	Western False Asphodel
HVR	GP	*Trichophorum clintonii*	OBL	FACU	Clinton's Leafless-Bulrush
HVR	GP	*Tridens muticus*	UPL	FACU	Awnless Fluff Grass
HVR	GP	*Trifolium nanum*	FACW	UPL	Tundra Clover
NPR	GP	*Asclepias sullivantii*	----	FAC	Prairie Milkweed
NPR	GP	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	GP	*Parapholis incurva*	FACW	FACU	Curved Sickle Grass
HVR	HI	*Cuphea hyssopifolia*	FACW	FACU	False Heather
HVR	HI	*Euphorbia serpens*	UPL	FACU	Matted Sandmat
HVR	HI	*Hemarthria altissima*	UPL	FAC	Limpo Grass
HVR	HI	*Hordeum brachyantherum*	UPL	FAC	Meadow Barley
HVR	HI	*Jacquemontia ovalifolia*	UPL	FACU	Oval-Leaf Clustervine
HVR	HI	*Muhlenbergia mexicana*	UPL	FAC	Mexican Muhly
HVR	HI	*Parkinsonia aculeata*	UPL	FACU	Mexican Palo-Verde
HVR	HI	*Piper aduncum*	UPL	FAC	Spiked Pepper
HVR	HI	*Sagina procumbens*	UPL	FAC	Bird-Eye Pearlwort
HVR	HI	*Tectaria incisa*	UPL	FACU	Incised Halberd Fern
HVR	HI	*Verbena bonariensis*	UPL	FACU	Purple-Top Vervain
HVR	HI	*Veronica peregrina*	UPL	FACU	Neckweed
NPR	HI	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
HVR	MW	*Andropogon gyrans*	UPL	FACU	Elliott's Bluestem
HVR	MW	*Crypsis schoenoides*	FACU	FACW	Swamp Prickle Grass
HVR	MW	*Dinebra panicoides*	OBL	FACW	Amazon Viper Grass
HVR	MW	*Echinochloa esculenta*	UPL	FACW	Japanese Water Grass
HVR	MW	*Echinochloa frumentacea*	FACW	FACU	Japanese-Millet
HVR	MW	*Persicaria orientalis*	UPL	FAC	Kiss-Me-Over-the-Garden-Gate
HVR	MW	*Pycnanthemum verticillatum*	UPL	FAC	Whorled Mountain-Mint
HVR	MW	*Quercus X beadlei*	UPL	FAC	
HVR	MW	*Rumex pulcher*	UPL	FAC	Fiddle Dock
HVR	MW	*Saccharum brevibarbe*	OBL	FACW	Short-Beard Plume Grass
HVR	MW	*Saccharum ravennae*	FACW	FAC	Ranenna Grass
HVR	MW	*Sambucus nigra*	FACW	FAC	Black Elder
HVR	MW	*Sisyrinchium fuscatum*	FACW	FACU	Coastal-Plain Blue-Eyed-Grass
HVR	MW	*Spiraea douglasii*	UPL	FAC	Douglas' Meadowsweet

Reason	Region	Scientific Name	2014	2016	Common Name
HVR	MW	*Tamarix parviflora*	UPL	FAC	Small-Flower Tamarisk
HVR	MW	*Trianthema portulacastrum*	FACW	FAC	Desert Horse-Purslane
NPR	MW	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	MW	*Parapholis incurva*	OBL	FACU	Curved Sickle Grass
PR	MW	*Asclepias sullivantii*	----	FAC	Prairie Milkweed
HVR	NCNE	*Carex pedunculata*	FACU	FAC	Long-Stalk Sedge
HVR	NCNE	*Lasthenia minor*	UPL	FAC	Coastal Goldfields
HVR	NCNE	*Persicaria orientalis*	UPL	FACU	Kiss-Me-Over-the-Garden-Gate
HVR	NCNE	*Persicaria posumbu*	UPL	FACU	Oriental Lady's-Thumb
HVR	NCNE	*Pycnanthemum verticillatum*	FACU	FAC	Whorled Mountain-Mint
HVR	NCNE	*Ranunculus bulbosus*	FACW	FAC	St. Anthony's-Turnip
HVR	NCNE	*Rumex pulcher*	UPL	FACU	Fiddle Dock
HVR	NCNE	*Senecio eremophilus*	OBL	FACW	Desert Ragwort
HVR	NCNE	*Solidago X asperula*	OBL	FACW	
HVR	NCNE	*Stellaria longipes*	FACU	FAC	Long-Stalk Starwort
HVR	NCNE	*Tamarix parviflora*	UPL	FAC	Small-Flower Tamarisk
NPR	NCNE	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	NCNE	*Parapholis incurva*	OBL	FACU	Curved Sickle Grass
PR	NCNE	*Asclepias sullivantii*	----	FAC	Prairie Milkweed
HVR	WMVC	*Amaranthus blitoides*	FACW	FAC	Mat Amaranth
HVR	WMVC	*Chaerophyllum tainturieri*	UPL	FAC	Hairy-Fruit Chervil
HVR	WMVC	*Conoclinium dissectum*	UPL	FACU	Pinked Mistflower
HVR	WMVC	*Crassula solieri*	OBL	FACW	Smooth-Seed Pygmyweed
HVR	WMVC	*Crocosmia X crocosmiiflora*	FACW	FAC	
HVR	WMVC	*Crypsis schoenoides*	FACW	OBL	Swamp Prickle Grass
HVR	WMVC	*Draba praealta*	FACW	FAC	Tall Whitlow-Grass
HVR	WMVC	*Echinochloa esculenta*	UPL	FACU	Japanese Water Grass
HVR	WMVC	*Echinochloa frumentacea*	FAC	FACU	Japanese-Millet
HVR	WMVC	*Enemion biternatum*	UPL	FAC	Eastern False Rue-Anemone
HVR	WMVC	*Erigeron glabellus*	FACW	FAC	Streamside Fleabane
HVR	WMVC	*Iris hartwegii*	OBL	FACU	Rainbow Iris
HVR	WMVC	*Mazus pumilus*	FACW	FAC	Japanese Mazus
HVR	WMVC	*Miscanthus sinensis*	FACW	FAC	Chinese Silver Grass
HVR	WMVC	*Parkinsonia aculeata*	FACU	FAC	Mexican Palo-Verde
HVR	WMVC	*Phragmites karka*	FAC	OBL	Tropical Reed
HVR	WMVC	*Plantago coronopus*	FACW	FAC	Buck-Horn Plantain
HVR	WMVC	*Rosa rubiginosa*	FACW	UPL	Sweetbrier
HVR	WMVC	*Rumex dentatus*	OBL	FACW	Toothed Dock
HVR	WMVC	*Persicaria orientalis*	FAC	FACW	Kiss-Me-Over-the-Garden-Gate
HVR	WMVC	*Sambucus nigra*	FACU	FAC	Black Elder
HVR	WMVC	*Sinapis alba*	OBL	FAC	White-Mustard
HVR	WMVC	*Spergularia echinosperma*	FACU	OBL	Bristle-Seed Sandspurry
HVR	WMVC	*Symphyotrichum pilosum*	UPL	FACU	White Oldfield American-Aster
HVR	WMVC	*Symphytum asperum*	FACW	FAC	Prickly Comfrey
HVR	WMVC	*Tamarix aphylla*	FACW	FAC	Athel Tamarisk
HVR	WMVC	*Tamarix gallica*	FACW	FAC	French Tamarisk
HVR	WMVC	*Tamarix parviflora*	FACW	FAC	Small-Flower Tamarisk
HVR	WMVC	*Tradescantia occidentalis*	FACW	FACU	Prairie Spiderwort
HVR	WMVC	*Vernonia baldwinii*	FACW	FACU	Western Ironweed
HVR	WMVC	*Veronica peregrina*	OBL	FACW	Neckweed
HVR	WMVC	*Vulpia bromoides*	FACU	FAC	Brome Six-Weeks Grass

Reason	Region	Scientific Name	2014	2016	Common Name
NPR	WMVC	*Bassia hyssopifolia*	FACW	FACU	Five-Horn Smotherweed
NPR	WMVC	*Parapholis incurva*	FACW	FACU	Curved Sickle Grass
PR	WMVC	*Bromus inermis*	FAC	UPL	Smooth Brome
PR	WMVC	*Rubus armeniacus*	FACU	FAC	Himalayan Blackberry
PR	WMVC	*Sisyrinchium pallidum*	----	FACU	Pale Blue-eyed Grass
PR	WMVC	*Stephanomeria fluminea*	----	FACW	Teton Wirelettuce
PR	HI/SPI	*Annona glabra*	----	OBL	
PR	HI/SPI	*Calopogonium mucunoides*	----	FAC	
PR	HI/SPI	*Cyperus iria*	----	FACW	
PR	HI/SPI	*Cyperus ligularis*	----	FAC	
PR	HI/SPI	*Dentella repens*	----	FAC	
PR	HI/SPI	*Desmanthus virgatus*	----	FACU	
PR	HI/SPI	*Eragrostis atrovirens*	----	FAC	
PR	HI/SPI	*Fimbristylis autumnalis*	----	FAC	
PR	HI/SPI	*Hygrophila difformis*	----	OBL	
PR	HI/SPI	*Hymenocallis littoralis*	----	FAC	
PR	HI/SPI	*Imperata cylindrica*	----	UPL	
PR	HI/SPI	*Lemna minor*	----	OBL	
PR	HI/SPI	*Lemna perpusilla*	----	OBL	
PR	HI/SPI	*Lygodium microphyllum*	----	UPL	
PR	HI/SPI	*Malachra capitata*	----	FACU	
PR	HI/SPI	*Malachra fasciata*	----	FACW	
PR	HI/SPI	*Mecardonia procumbens*	----	FACW	
PR	HI/SPI	*Persicaria minor*	----	OBL	
PR	HI/SPI	*Potamogeton illinoensis*	----	OBL	
PR	HI/SPI	*Pteris plumula*	----	FAC	
PR	HI/SPI	*Rhynchospora colorata*	----	FAC	
PR	HI/SPI	*Scoparia dulcis*	----	FAC	
PR	HI/SPI	*Xanthosoma sagittifolium*	----	FACW	
PR	HI/SPI	*Cheilanthes tenuifolia*	----	FAC	
PR	HI/SPI	*Curcuma australasica*	----	FAC	
PR	HI/SPI	*Cycas micronesica*	----	UPL	
PR	HI/SPI	*Cyclosorus truncatus*	----	FACW	
PR	HI/SPI	*Cyperus compactus*	----	FACW	
PR	HI/SPI	*Cyperus flavidus*	----	FAC	
PR	HI/SPI	*Cyrtococcum oxyphyllum*	----	FAC	
PR	HI/SPI	*Decaspermum fruticosum*	----	FAC	
PR	HI/SPI	*Dianella saffordiana*	----	FACU	
PR	HI/SPI	*Dichanthium caricosum*	----	FAC	
PR	HI/SPI	*Discocalyx megacarpa*	----	UPL	
PR	HI/SPI	*Fimbristylis tristachya*	----	FAC	
PR	HI/SPI	*Gomphrena serrata*	----	FAC	
PR	HI/SPI	*Heterogonium pinnatum*	----	FACW	
PR	HI/SPI	*Histiopteris incisa*	----	FAC	
PR	HI/SPI	*Homalomena rubescens*	----	FAC	
PR	HI/SPI	*Isachne globosa*	----	FACW	
PR	HI/SPI	*Ischaemum polystachyum*	----	FACW	
PR	HI/SPI	*Laportea ruderalis*	----	FAC	
PR	HI/SPI	*Lygodium auriculatum*	----	FAC	
PR	HI/SPI	*Maoutia australis*	----	FAC	
PR	HI/SPI	*Medinilla medinilliana*	----	FAC	

Reason	Region	Scientific Name	2014	2016	Common Name
PR	HI/SPI	*Melinis minutiflora*	----	FAC	
PR	HI/SPI	*Miscanthus floridulus*	----	FACU	
PR	HI/SPI	*Monstera deliciosa*	----	FAC	
PR	HI/SPI	*Operculina turpethum*	----	FACU	
PR	HI/SPI	*Phyllanthus marianus*	----	FAC	
PR	HI/SPI	*Phyllanthus saffordii*	----	FAC	
PR	HI/SPI	*Pimenta racemosa*	----	FAC	
PR	HI/SPI	*Pogonatherum crinitum*	----	FACW	
PR	HI/SPI	*Pteris ensiformis*	----	FAC	
PR	HI/SPI	*Schoenoplectus litoralis*	----	OBL	
PR	HI/SPI	*Schoenus punctatus*	----	FAC	
PR	HI/SPI	*Syngonium angustatum*	----	FAC	
PR	HI/SPI	*Teramnus labialis*	----	FAC	
PR	HI/SPI	*Terminalia samoensis*	----	FAC	
PR	HI/SPI	*Thelypteris guamensis*	----	FAC	
PR	HI/SPI	*Tradescantia pallida*	----	FAC	
PR	HI/SPI	*Nephrolepis falcata*	UPL	FACU	
PR	HI/SPI	*Talipariti tiliaceum*	FAC	FACW	
PR	HI/SPI	*Urochloa mutica*	FAC	FACW	
PR	SPI	*Abildgaardia ovata*	FAC	FACW	Flat-Spike Sedge
PR	SPI	*Abrus precatorius*	UPL	UPL	Rosary-Pea
PR	SPI	*Abutilon indicum*	FACU	FACU	Monkeybush
PR	SPI	*Achyranthes aspera*	FACU	FACU	Devil's-Horsewhip
PR	SPI	*Alternanthera sessilis*	FAC	FACW	Sessile Joyweed
PR	SPI	*Alysicarpus vaginalis*	UPL	FAC	White Moneywort
PR	SPI	*Arundina graminifolia*	UPL	FACU	Bamboo Orchid
PR	SPI	*Asplenium polyodon*	UPL	FACU	Birdnest Fern
PR	SPI	*Bidens pilosa*	FACU	FACU	Hairy Beggarticks
PR	SPI	*Bolbitis quoyana*	FAC	FACW	
PR	SPI	*Bothriochloa bladhii*	FACU	FACU	Australian Beard Grass
PR	SPI	*Caesalpinia bonduc*	UPL	FAC	Yellow Nicker
PR	SPI	*Calophyllum inophyllum*	FACU	UPL	Alexandrian-Laurel
PR	SPI	*Cananga odorata*	FACU	FACU	Perfumetree
PR	SPI	*Centrosema pubescens*	FACU	FACU	Mexican Butterfly-Pea
PR	SPI	*Cerbera dilatata*	FAC	FACU	
PR	SPI	*Chamaecrista nictitans*	FACU	FACU	Partridge-Pea
PR	SPI	*Christella parasitica*	NOL	FAC	
PR	SPI	*Chromolaena odorata*	FACU	UPL	Jack-in-the-Bush
PR	SPI	*Coix lacryma-jobi*	FACW	FACW	Job's-Tears
PR	SPI	*Colocasia esculenta*	OBL	FACW	Coco-Yam
PR	SPI	*Colubrina asiatica*	FAC	FACU	Asian Nakedwood
PR	SPI	*Corchorus aestuans*	FACU	FAC	Jute
PR	SPI	*Cordia subcordata*	FACU	UPL	Kou
PR	SPI	*Crassocephalum crepidioides*	FACU	FAC	Red-Flower Ragleaf
PR	SPI	*Crotalaria incana*	UPL	UPL	Shakeshake
PR	SPI	*Crotalaria spectabilis*	UPL	UPL	Showy Rattlebox
PR	SPI	*Cuphea hyssopifolia*	FACU	FAC	False Heather
PR	SPI	*Curcuma longa*	FACU	UPL	Common Turmeric
PR	SPI	*Cyanthillium cinereum*	FACU	FAC	Little-Ironweed
PR	SPI	*Cyclosorus interruptus*	OBL	FACW	Neke
PR	SPI	*Cyperus haspan*	FACW	OBL	Sheathed Flat Sedge

Reason	Region	Scientific Name	2014	2016	Common Name
PR	SPI	*Cyperus involucratus*	OBL	FACW	Alternate-Leaf Flat Sedge
PR	SPI	*Cyperus javanicus*	FACW	FAC	Javanese Flat Sedge
PR	SPI	*Cyperus rotundus*	FACU	FAC	Purple Flat Sedge
PR	SPI	*Dalbergia candenatensis*	FAC	FACW	
PR	SPI	*Dendrolobium umbellatum*	FACU	FACU	
PR	SPI	*Derris trifoliata*	FAC	FAC	
PR	SPI	*Desmanthus pernambucanus*	FACU	FACU	Pigeon Bundle-Flower
PR	SPI	*Desmodium incanum*	FACU	FAC	Zarzabacoa-Comun
PR	SPI	*Elephantopus mollis*	FACU	FAC	Soft Elephant's-Foot
PR	SPI	*Entada phaseoloides*	FACU	FACU	St. Thomas-Bean
PR	SPI	*Eragrostis ciliaris*	UPL	FAC	Gopher-Tail Love Grass
PR	SPI	*Euphorbia hirta*	FACU	FACU	Pill-Pod Sandmat
PR	SPI	*Euphorbia prostrata*	FACU	FACU	Prostrate Sandmat
PR	SPI	*Eustachys petraea*	UPL	FACU	Pinewoods Finger Grass
PR	SPI	*Excoecaria agallocha*	FAC	FACU	
PR	SPI	*Fimbristylis littoralis*	FACW	FACW	Grass-Like Fimbry
PR	SPI	*Flagellaria indica*	FACU	FACU	
PR	SPI	*Freycinetia reineckei*	FAC	FACU	
PR	SPI	*Gleichenia linearis*	FAC	FACU	
PR	SPI	*Hernandia sonora*	UPL	FACU	Mago
PR	SPI	*Heteropogon contortus*	FACU	FACU	Twisted Tanglehead
PR	SPI	*Hippobroma longiflora*	FACU	FACU	Madamfate
PR	SPI	*Indigofera suffruticosa*	UPL	FAC	Anil-de-Pasto
PR	SPI	*Ipomoea indica*	FAC	FACU	Ocean-Blue Morning-Glory
PR	SPI	*Ipomoea littoralis*	FAC	FAC	White Beach Morning-Glory
PR	SPI	*Lepidium virginicum*	UPL	FAC	Poorman's-Pepperwort
PR	SPI	*Leucaena leucocephala*	UPL	UPL	White Leadtree
PR	SPI	*Lindsaea repens*	FACU	FACW	Creeping Necklace Fern
PR	SPI	*Liparis guamensis*	FACU	FACW	
PR	SPI	*Macaranga thompsonii*	FACU	UPL	
PR	SPI	*Macrothelypteris torresiana*	FACU	FAC	False Maiden Fern
PR	SPI	*Maytenus thompsonii*	FACU	UPL	
PR	SPI	*Megathyrsus maximus*	FAC	FACU	Guinea Grass
PR	SPI	*Melinis repens*	FACU	FAC	Creeping Molasses Grass
PR	SPI	*Melochia villosissima*	FACU	FACU	
PR	SPI	*Mesosphaerum pectinatum*	UPL	FACU	
PR	SPI	*Mesosphaerum suaveolens*	UPL	FACU	Pignut
PR	SPI	*Microlepia speluncae*	FACU	FACU	Limp-Leaf Fern
PR	SPI	*Mimosa pudica*	FACU	FACU	Shameplant
PR	SPI	*Mucuna gigantea*	FACU	FAC	Sea-Bean
PR	SPI	*Muntingia calabura*	FACU	FACU	Strawberry-Tree
PR	SPI	*Musa X paradisiaca*	FACU	FACU	
PR	SPI	*Nephrolepis cordifolia*	FAC	FACU	Narrow Sword Fern
PR	SPI	*Nephrolepis hirsutula*	FAC	FACU	Scaly Sword Fern
PR	SPI	*Nervilia aragoana*	FACU	FAC	
PR	SPI	*Nervilia jacksoniae*	FACU	FAC	
PR	SPI	*Nervilia platychila*	FAC	FACW	
PR	SPI	*Ochrosia mariannensis*	FACU	UPL	
PR	SPI	*Oplismenus compositus*	FACU	FACU	Running Mountain Grass
PR	SPI	*Oxalis corniculata*	FACU	FACU	Creeping Yellow Wood-Sorrel
PR	SPI	*Paraderris elliptica*	FACU	FAC	Tubaroot

Reason	Region	Scientific Name	2014	2016	Common Name
PR	SPI	*Paspalum distichum*	FAC	FACW	Jointed Crown Grass
PR	SPI	*Peperomia mariannensis*	FAC	FACU	
PR	SPI	*Phyllanthus amarus*	FACU	FAC	Carry-Me-Seed
PR	SPI	*Physalis angulata*	FAC	FACU	Cut-Leaf Ground-Cherry
PR	SPI	*Pipturus argenteus*	FAC	FACU	
PR	SPI	*Pisonia grandis*	FACU	UPL	Grand Catchbirdtree
PR	SPI	*Polygala paniculata*	FACU	FACU	Orosne
PR	SPI	*Portulaca oleracea*	FACU	FAC	Little-Hogweed
PR	SPI	*Pouteria obovata*	FACU	UPL	
PR	SPI	*Rhynchospora corymbosa*	OBL	FACW	Matamat
PR	SPI	*Rhynchospora rubra*	OBL	FAC	
PR	SPI	*Saccharum spontaneum*	FAC	FACU	Wild Sugar-Cane
PR	SPI	*Schizaea dichotoma*	FACU	FAC	
PR	SPI	*Sida rhombifolia*	FACU	FACU	Cuban-Jute
PR	SPI	*Spathoglottis carolinensis*	FACU	FACU	
PR	SPI	*Spathoglottis micronesiaca*	FACU	FACU	
PR	SPI	*Spathoglottis plicata*	FACU	FACU	Philippine Ground Orchid
PR	SPI	*Spirodela polyrhiza*	OBL	FAC	Common Duckmeat
PR	SPI	*Sporobolus indicus*	FACU	FACU	Smut Grass
PR	SPI	*Sporobolus virginicus*	FAC	FAC	Seashore Dropseed
PR	SPI	*Stachytarpheta australis*	FACU	FACW	Branched Porterweed
PR	SPI	*Stachytarpheta cayennensis*	FACU	FACW	Cayenne Porterweed
PR	SPI	*Stachytarpheta jamaicensis*	FACU	FACU	Blueflower
PR	SPI	*Swietenia mahagoni*	UPL	FACU	West Indian Mahogany
PR	SPI	*Syzygium malaccense*	FACU	FACU	Malaysian-Apple
PR	SPI	*Tarenna sambucina*	FACU	FAC	
PR	SPI	*Terminalia catappa*	FACU	FACW	Tropical-Almond
PR	SPI	*Thelypteris opulenta*	FACW	FAC	Jeweled Maiden Fern
PR	SPI	*Thelypteris subpubescens*	FACU	FACW	
PR	SPI	*Thelypteris unita*	FACU	FACW	
PR	SPI	*Thelypteris warburgii*	FAC	FACW	
PR	SPI	*Trichomanes brevipes*	FACU	FAC	
PR	SPI	*Trichomanes javanicum*	FACU	FAC	
PR	SPI	*Tridax procumbens*	FACU	FAC	Coatbuttons
PR	SPI	*Triphasia trifolia*	FAC	UPL	Limeberry
PR	SPI	*Urochloa distachya*	UPL	FAC	Tropical Liverseed Grass
PR	SPI	*Utricularia bifida*	FACW	OBL	
PR	SPI	*Utricularia caerulea*	FAC	OBL	
PR	SPI	*Vigna adenantha*	FACU	FAC	Wild Pea
PR	SPI	*Waltheria indica*	FACU	FACU	Basora-Prieta
PR	SPI	*Youngia japonica*	FACU	FAC	Oriental False Hawk's-Beard
PR	SPI	*Zeuxine fritzii*	FACU	FACW	

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NEW DISTRIBUTION RECORDS FOR ACANTHACEAE IN EL SALVADOR WITH A LIST OF NATIVE AND NATURALIZED SPECIES NOTING OCCURRENCES BY DEPARTMENT

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ABSTRACT

Twenty-four new departmental records for occurrences of 21 species of Acanthaceae within El Salvador are reported; four species (*Carlowrightia arizonica*, *Dicliptera sciadephora*, *Justicia micrantha*, and *Pseuderanthemum cuspidatum*) are also new distribution records for the country. Images of 12 of these species are presented. Notes on distributions, taxonomy, and morphology are provided where appropriate. A list of all native and naturalized species of Acanthaceae occurring in El Salvador, and the known departments of occurrence for each, is also provided.

RESUMEN

Veinticuatro nuevos registros departamentales de ocurrencias de 21 especies de Acanthaceae, se reportan dentro de El Salvador; cuatro especies (*Carlowrightia arizonica*, *Dicliptera sciadephora*, *Justicia micrantha* y *Pseuderanthemum cuspidatum*) también son registros distribucionales nuevos para el país. Se presentan imágenes de 12 de estas especies. Se incluyen notas sobre las distribuciones, taxonomía, y morfología cuando es apropiado. Se proporciona una lista de todas las especies nativas y naturalizadas de Acanthaceae que ocurren en El Salvador, y los departamentos conocidos de ocurrencia para cada uno.

With recent collecting efforts in El Salvador, new occurrences of native and naturalized species of Acanthaceae both to and within the country continue to accumulate. Below, we report 24 new departmental records for 21 species of Acanthaceae. Four of these species, *Carlowrightia arizonica*, *Dicliptera sciadephora*, *Justicia micrantha*, and *Pseuderanthemum cuspidatum*, are also reported from the country for the first time. These additions result in 54 native and naturalized species of the family that are known to occur in El Salvador. In addition to the species previously noted for the country (Daniel 2001, 2012; Rodríguez & Daniel 2014) and those noted below, two additional species (*Avicennia bicolor* Standl. and *A. germinans* (L.) L.) that are now recognized as pertaining to Acanthaceae (e.g., McDade et al. 2008) are also included on the list in Appendix 1. Photographs of flowers for 12 of the 21 species noted below are provided.

Within El Salvador, *Aphelandra scabra* is the only species of Acanthaceae currently known from all 14 departments. The departments with the greatest numbers of species of native and naturalized Acanthaceae in El Salvador are the two westernmost, Santa Ana (35) and Ahuachapán (32). Daniel (2001, 2012) discussed perceived disparities in the numbers of species of Acanthaceae in several departments of the country.

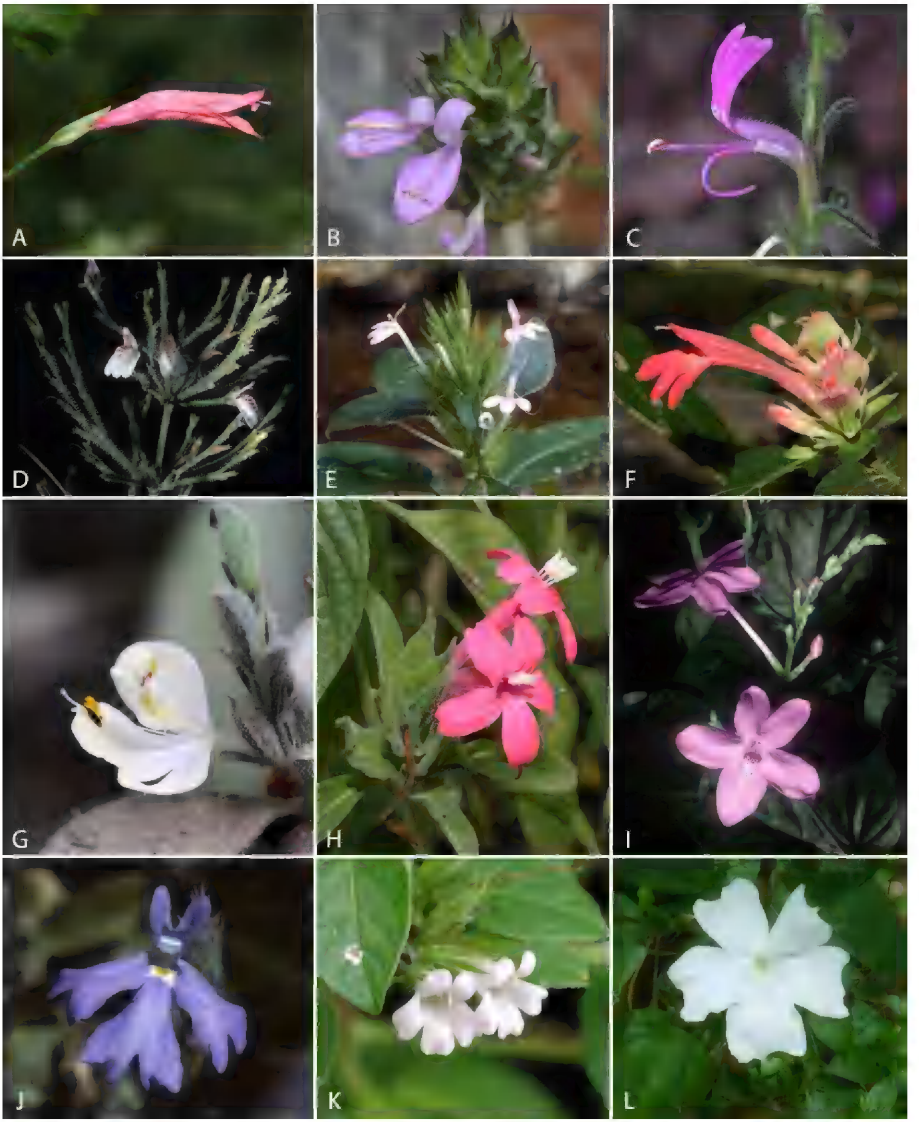

Figure 1. Photographs (by the authors) of some Acanthaceae that occur in El Salvador. A. *Dicliptera sciadephora*. B. *Dicliptera unguiculata*. C. *Hypoestes phyllostachya*. D. *Justicia comata*. E. *Justicia micrantha*. F. *Lepidagathis guatemalensis*. G. *Henrya insularis*. H. *Ruellia megasphaera*. I. *Pseuderanthemum cuspidatum*. J. *Elytraria imbricata*. K. *Dyschoriste quadrangularis*. L. *Thunbergia fragrans*.

CARLOWRIGHTIA ARIZONICA A. Gray

Santa Ana: Mpio. Metapan, alrededores de San Jerónimo, 27 XII 2015 (frt), *J. Linares et al. 11208* (MEXU).

This is the first report of this widespread and morphologically variable species in El Salvador. It has been previously reported from the USA, Mexico, Guatemala, Honduras, Nicaragua, and Costa Rica.

DICLIPTERA cf. INUTILIS Leonard

San Miguel: El Pacayal, 13°28'N, 088°19'W, vegetación intervenida a orilla de la calle polvosa que va hacia el cráter, 4-II-1999 (flr), *R. Villacorta, K. Sidwell, et al. 2823* (LAGU).

A collection of *Dicliptera* from Morazán (*Tucker 748*) was treated by Daniel (2001) as an undetermined species with similarities to *D. membranacea* Leonard. Subsequently, Daniel (2010) studied and provided a key to the species of *Dicliptera* in Guatemala. *Tucker 748* and other similar collections from Morazán in El Salvador (e.g., *Berendsohn et al. 1795*, *Rodríguez et al. 4567*) more closely resemble *D. inutilis* Leonard, which was described from the department of Jutiapa in southeastern Guatemala. However, *D. inutilis* is known from limited materials and remains incompletely characterized (Daniel 2010). *Villacorta et al. 2823* extends the range of this species, here treated as *D.* cf. *inutilis*, to the department of San Miguel.

The following brief description is based on Salvadoran plants from Morazán and San Miguel: sprawling to erect perennial herbs to 2 m; young stems pubescent with antrorse eglandular trichomes to 0.4 mm long, and often also with a sparse to dense overstory of flexuose eglandular trichomes up to 0.8 mm long; leaves petiolate, petioles to 50 mm long, blades ovate to ovate-elliptic, 81–115 mm long × 40–66 mm wide, length:width = 1.7–2; inflorescence of subsessile to pedunculate cymes in axils of leaves, peduncles 1–97 mm long, cymes subtended by a pair of subfoliose bracts (7–34 mm long × 2–17 mm wide), bearing 3–5 cymules, cymules sessile, outer cymule bracteoles lance-ovate to ovate-elliptic, 9–23 mm long × 3–13 mm wide (the pair unequal in size), abaxially pubescent with antrorsely appressed eglandular trichomes and inconspicuously puberulent with erect subglandular trichomes 0.05 mm long, apically lacking a mucro or with a mucro to 0.1 mm long; calyx 7.5 mm long, lobes lanceolate, 6–6.5 mm long; corolla reddish purple, 23–24 mm long, externally pubescent with erect to flexuose eglandular trichomes and also with sparse glandular trichomes (<0.1 mm long); stamens with filaments sparsely pubescent with eglandular trichomes, anther thecae superposed (contiguous or with a gap to 0.1 mm), 0.9–1 mm long; style sparsely pubescent with eglandular trichomes; capsule and seed not seen. Plants occur in regions (sometimes disturbed) of tropical semideciduous forests at elevations from 1220 to 1330 meters.

Guatemalan plants of *Dicliptera inutilis* differ from these Salvadoran collections by having bracts subtending the cymes linear to obovate to oblanceolate and generally smaller (2–9 mm long × 0.3–2.5 mm wide), cymules borne on peduncles 1.5–3 mm long, outer cymule bracteoles ovate to deltate, and calyces shorter (5.2–5.7 mm long). Additional collections from both countries may confirm that these putative differences pertain to different taxa or reveal them to be part of a continuum in a single taxon. A morphologically similar species from Costa Rica, *D. pallida* Leonard, differs from these Guatemalan and Salvadoran plants by its obovate to elliptic outer cymule bracteoles, the apex of which terminates in a conspicuous mucro up to 1 mm long.

DICLIPTERA SCIADEPHORA Donn. Sm., Fig. 1A

Santa Ana: Mpio. Metapán, San José Ingenio, P.N. Montecristo, Quebrada Las Huertas, alrededores de cascada, 14°23'16"N, 089°22'25"W, 1738 m, bosque tropical semideciduo mixto, submontano, 15-I-2015 (flr), *P. Galán & A. López 3243* (CAS, LAGU); Mpio. Metapán, San José Ingenio, P.N. Montecristo, Quebrada El Pico Gordo, 14°24'07"N, 89°22'14"W, 2051 m, bosque

tropical semideciduo mixto, submontano, 15-I-2015 (flr), *D. Rodríguez & S. García 5130* (CAS, LAGU).

This species is herewith newly reported from El Salvador, where it occurs in the department of Santa Ana. *Dicliptera sciadephora* has been documented previously from Mexico (Chiapas, Oaxaca), Guatemala, and Nicaragua.

DICLIPTERA UNGUICULATA Nees, Fig. 1B

La Libertad: Mpio. Santa Tecla, P.N. El Boquerón, cumbre y alrededores de la cafetería de Doña Trini, 13°43'53"N, 89°16'54"W, 1781 m, zona natural alterada por cultivos agrícolas y florales, 19-III-2014 (flr), *D. Rodríguez, P. Galán, R. Sánchez, R. Villacorta & F. Perla 4670* (CAS, LAGU).

DYSCHORISTE QUADRANGULARIS (Oerst.) Kuntze, Fig. 1K

Santa Ana: Mpio. Metapán, P.N. San Diego-La Barra, alrededores de la entrada del parque, sendero autoguiado, 465 m, 14°15'N, 89°27'W, bosque seco, habitando a la orilla del sendero en lugares sombrios, 10-XI-2010 (flr), *D. Rodríguez & A. Tejada 2161* (LAGU).

ELYTRARIA IMBRICATA (Vahl) Pers., Fig. 1J

Cabañas: Mpio. Tejutepeque, Area Natural Bosque de Cinquera, Lugar de La Tigra, Los Encuentros, 13°50'49"N, 88°58'59"W, 425 m, 16-XI-2007 (flr*), J. Menívar, G. Cerén, M. A. Hernández, E. Echeverría & R. Avalos 1753* (MHES).

HENRYA INSULARIS Nees, Fig. 1G

Morazán: Mpio. Chilanga, Joya del Matazano, A.N.P. Cerro Cacahuatique, Sendero Carbón, 13°45'47"N, 88°11'58"W, 1223 m, Bosque tropical semideciduo latifoliado, submontano, 23-I-2014 (flr), *D. Rodríguez & G. Pineda 4570* (CAS, LAGU).

HYPOESTES PHYLLOSTACHYA Baker, Fig. 1C

Morazán: Mpio. Chilanga, Ctón. Joya del Matazano, Crío. Los Cimientos, A.N.P. Cerro Cacahuatique, alrededores del Centro de Operaciones y Torre del Mirador, 13°45'34"N, 88°11'59"W, 1126 m, bosque tropical semideciduo latifoliado, submontano, 27-XI-2013 (flr, frt), *P. Galán & D. Rodríguez 2733* (CAS, LAGU); Chilanga, Joya del Matazano, A.N.P. Cerro Cacahuatique, sendero hacia La Chacara, 13°45'36"N, 88°11'53"W, 1030 m, bosque tropical semideciduo latifoliado, submontano, 27-XI-2013 (flr, frt), *D. Rodríguez & R. Cabrera 4501* (CAS, LAGU).

JUSTICIA COMATA (L.) Lam., Fig. 1D

Sonsonate: Mpio. Caluco, A.N.P. Complejo Los Farallones, sector El Carmen, La Presa, 13°43'29"N, 89°37'03"W, 466 m, bosque tropical deciduo latifoliado, tierras bajas, 17-IX-2012 (flr, frt), *D. Rodríguez & R. Romero 3525* (CAS, LAGU).

JUSTICIA MICRANTHA (Oerst.) V.A.W. Graham, Fig. 1E

Santa Ana: Mpio. Metapán, San José Ingenio, P.N. Montecristo, Río San José, abajo del casco de la antigua hacienda, 14°21'20"N, 89°24'23"W, 802 m, bosque tropical deciduo latifoliado, montano inferior, 19-I-2016 (flr), *D. Rodríguez & N. López 5471* (CAS, LAGU).

This is the first report of *Justicia micrantha* from El Salvador. Daniel (2010) provided a description of the species, images of its pollen, and a list of its synonyms. It also occurs in Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Nicaragua, Panama, and Venezuela. Corollas of plants from elsewhere in Central America (e.g., Durkee 1978, 1986, both as *Chaetothylax leucanthus* Leonard; Daniel 2010) and South America (e.g., Leonard 1958) have been noted to be white. Corollas of the Salvadoran collection have pale lilac corollas with slightly darker markings on the lower lip.

JUSTICIA PECTORALIS Jacq.

San Salvador: Cd. de San Salvador, Universidad Nacional, 23-I-1989 (flr), *S. Ramirez s.n.* (*Villacorta 226*) (LAGU).

Justicia pectoralis was reported as cultivated in the department of La Libertad (Daniel 2001). This collection from San Salvador was noted to have medicinal uses and was possibly cultivated as well. Considering its native occurrences in surrounding regions of Central America, this species undoubtedly occurs in wet habitats in El Salvador as well.

LEPIDAGATHIS GUATEMALENSIS (Donn. Sm.) Kameyama, Fig. 1F

Sonsonate: Mpio. Izalco, Las Lajas, A.N.P. Complejo San Marcelino, Bosque Las Lajas, Sector Las Tumbas, Ruta Prioritaria 3, 13°49'37"N, 089°34'11"W, 1088 m, bosque tropical húmedo, 12-IV-2012 (flr), *D. Rodríguez & R. Guerrero 2824* (CAS, LAGU).

This species was listed by Daniel (2001) as *Lophostachys guatemalensis* Donn. Sm.

PSEUDERANTHEMUM CUSPIDATUM (Nees) V.M. Baum, Fig. 1I

Morazán: Mpio. Chilanga, Ctón. Joya del Matazano, Crío. Los Cimientos, A.N.P. Cerro Cacahuatique, Cueva del Manune, 13°45'47"N, 088°12'04"W, 1107 m, bosque tropical semideciduo latifoliado, submontano, 12-XI-2013 (frt), *P. Galán & J. Pineda 2710* (CAS, LAGU); Chilanga, Joya del Matazano, A.N.P. Cerro Cacahuatique, sendero hacia La Chacara, 13°45'36"N, 088°11'53"W, 1030 m, bosque tropical semideciduo latifoliado, submontano, 27-XI-2013 (frt), *D. Rodríguez & R. Cabrera 4515* (CAS, LAGU).

Santa Ana: Mpio. Chalchuapa, Cantón El Paste, Volcán Chingo, sendero principal al cráter, 13°07'03"N, 089°43'22"W, 1607 m, bosque tropical semideciduo latifoliado, montano inferior, 23-X-2012 (frt), *D. Rodríguez & O. Marroquín 3690* (CAS, LAGU).

On these three fruiting collections many or most of the flowers appear to have been cleistogamous ones based on the presence of very short (i.e., to 1.5 mm long) styles present at some nodes at which no fruits formed. This may account for some of the shorter than usual calyces (2.5–3 mm long) on the collections from Morazán. Otherwise the length of the calyces (3–4.5 mm long) and the acute- to attenuate-decurrent bases of the leaf blades confirm the identity of this species, the occurrence of which in El Salvador is recorded for the first time. Daniel (1995) provided a key to *Pseuderanthemum* in Chiapas, Mexico, that includes the species that occur (or are likely to occur) in El Salvador.

PSEUDERANTHEMUM PRAECOX (Benth.) Leonard

San Miguel: Mpio. Chinameca, Cerro El Pacayal, Laguna Seca, 13°28'N, 088°19'W, 4-II-1999 (flr, frt), *M. Renderos, R. Villacorta et al. 671* (LAGU).

Daniel (2001) recognized both *Pseuderanthemum praecox* and *P. fasciculatum* (Oerst.) Leonard as occurring in El Salvador. Subsequent observations suggest that these names may pertain to a single species (Daniel 2004, 2005), but additional studies of this species complex are desirable.

RUELLIA GEMINIFLORA Kunth

Chalatenango: Mpio. Citalá, Cerro Las Burreras, 850 m, 14°21'N, 089°13'W, 5-V-1999 (flr), *M. Renderos & M. Hernández 696* (LAGU).

Cuscatlán: Volcán de Guazapa, 1000 m, 13°55'N, 089°08'W, vegetación secundaria, 7-V-1997 (frt), *R. Villacorta & A. Araniva 2545* (LAGU).

San Vicente: Mpio. San Vicente, Ctón. y Crío. La Joya, A.N.P. La Joya, cima de La Tequera, 13°35'46"N, 088°42'55"W, bosque tropical semideciduo latifoliado, tierras bajas, 05-VI-2013 (frt), P. *Galán & A. Escolán 2359* (CAS, LAGU).

RUELLIA HOOKERIANA (Nees) Hemsl.

Chalatenango: Mpio. Citalá, Gualcho, 6-VIII-1998 (flr), *L. Lara 278* (MHES).

RUELLIA MEGASPHAERA Lindau, Fig. 1H

Morazán: Mpio. Chilanga Joya del Matazano, A.N.P. Cerro Cacahuatique, Quebrada La Chacara, 13°45'36"N, 88°11'53"W, 1030 m, bosque tropical semideciduo latifoliado, submontano, 24-I-2014 (flr), *D. Rodríguez, W. Berendsohn & J. Pineda 4598* (CAS, LAGU).

RUELLIA PUBERULA (Leonard) Tharp & F.A. Barkley

San Vicente: Mpio. Tecoluca, Ctón. El Palomar, Hacienda Los Tihuilotes, alrededores de La Laguna de Salazar, 13°28'21"N, 88°43'51"W, 64 m, sabana, 22-XII-2013 (flr, frt*), P. Galán & J. Alonso 2745* (CAS, LAGU).

Daniel (1995, 2001) discussed some of the variation observed in this species. *Galán & Alonso 2745* has young stems puberulent with erect to retrorse eglandular (only) trichomes to 0.1 mm long, corollas mostly pubescent with eglandular trichomes but with a few scattered glandular trichomes, and capsules pubescent throughout with only eglandular trichomes.

TETRAMERIUM NERVOSUM Nees

San Salvador: Los Planes de Renderos, 13°37'32.94"N, 89°11'22.23"W, 1042 m, 5-III-2006 (flr. frt), *L. Linares, E. Montalvo, E. Guerrero, E. Echeverría, L. Lara, J. Menívar & G. Cerén 8420* (MHES).

THUNBERGIA ALATA Bojer ex Sims

Santa Ana: Mpio. Metapán, P.N. Montecristo, Crío. Majaditas, Buena Vista, entrada al Roblarón, 14°23'34"N, 089°23'09"W, 1269 m, bosque tropical semideciduo mixto montano inferior, 11-VI-2015 (flr), *P. Galán & V. Martínez 3365* (CAS, LAGU).

THUNBERGIA FRAGRANS Roxb., Fig. 1L

Sonsonate: Mpio. Armenia, Ctón. 3 Ceibas, Crío. Paso Hondo, ANP Complejo San Marcelino, Sector El Teshcal, 39°47'06"N, 089°29'40"W, 530 m, vegetación secundaria, 11-IV-2012 (flr), *P. Galán & A. Calderón 1310* (LAGU).

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Appendix 1. List of native and naturalized species of Acanthaceae in El Salvador with departments of occurrence.

Anisacanthus tetracaulis Leonard (1): Morazán
Aphelandra gigantiflora Lindau (5): Ahuachapán, La Libertad, Santa Ana, San Vicente, Sonsonate
Aphelandra heydeana Donn. Sm. (3): Chalatenango, La Libertad, Santa Ana
Aphelandra scabra (Vahl) Sm. (14): Ahuachapán, Cabañas, Chalatenango, Cuscatlán, La Libertad, La Paz, La Unión, Morazán, San Miguel, San Salvador, Santa Ana, San Vicente, Sonsonate, Usulután
Aphelandra schiedeana Schltdl. & Cham. (3): Ahuachapán, Santa Ana, Sonsonate
Avicennia bicolor Standl. (1): Ahuachapán
Avicennia germinans (L.) L. (6): Ahuachapán, La Libertad, La Paz, La Unión, Sonsonate, Usulután
Barleria oenotheroides Dum. Cours. (7): Cabañas, La Unión, Morazán, San Miguel, Santa Ana, San Vicente, Sonsonate
Bravaisia integerrima (Spreng.) Standl. (3): La Libertad, San Miguel, Usulután
Carlowrightia arizonica A. Gray (1): Santa Ana
Carlowrightia hintonii T.F. Daniel (1): Ahuachapán
Chileranthemum pyramidatum (Lindau) T.F. Daniel (1): Ahuachapán
Dicliptera cf. *inutilis* Leonard. (2): Morazán, San Miguel
Dicliptera membranacea Leonard (2): Ahuachapán, Sonsonate
Dicliptera sciadephora Donn. Sm. (1): Santa Ana
Dicliptera sexangularis (L.) Juss. (5): Ahuachapán, La Libertad, San Salvador, San Vicente, Sonsonate
Dicliptera unguiculata Nees (4): Ahuachapán, La Libertad, San Salvador, Santa Ana
Dyschoriste hirsutissima (Nees) Kuntze (1): unknown (see Daniel 2001)
Dyschoriste quadrangularis (Oerst.) Kuntze (2): Ahuachapán, Santa Ana
Elytraria imbricata (Vahl) Pers. (12): Ahuachapán, Cabañas, Chalatenango, La Libertad, La Unión, Morazán, San Miguel, San Salvador, Santa Ana, San Vicente, Sonsonate, Usulután
Henrya insularis Nees ex Benth. (9): Ahuachapán, Chalatenango, La Libertad, Morazán, San Salvador, Santa Ana, San Vicente, Sonsonate, Usulután
Hygrophila costata Nees (1): Morazán
Hypoestes phyllostachya Baker (5): Ahuachapán, Chalatenango, La Libertad, La Unión, Morazán (naturalized in departments noted)
Justicia aurea Schltdl. (7): Ahuachapán, Chalatenango, La Libertad, Morazán, San Salvador, Santa Ana, Sonsonate (collections from some departments possibly cultivated only)
Justicia breviflora (Nees) Rusby (2): Cabañas, Cuscatlán
Justicia calliantha Leonard (1): Morazán

Justicia colorifera V.A.W. Graham (7): Ahuachapán, Chalatenango, La Libertad, San Salvador, Santa Ana, San Vicente, Sonsonate
Justicia comata (L.) Lam. (7): Ahuachapán, La Libertad, La Unión, Santa Ana, San Vicente, Sonsonate, Usulután
Justicia micrantha (Oerst.) V.A.W. Graham (1): Santa Ana
Justicia pectoralis Jacq. (1): La Libertad (noted as cultivated), San Salvador (probably cultivated; to be expected as a native; see Daniel 2001)
Justicia ramosa (Oerst.) V.A.W. Graham (1): Ahuachapán
Justicia soliana Standl. (5): Ahuachapán, La Libertad, San Miguel, Santa Ana, Sonsonate
Justicia spicigera Schltdl. (1): San Salvador
Justicia sulfurea (Donn. Sm.) D.N. Gibson (1): Ahuachapán
Lepidagathis guatemalensis (Donn. Sm.) Kameyama (4): Ahuachapán, Santa Ana, San Vicente, Sonsonate
Nelsonia canescens (Lam.) Spreng. (10): Ahuachapán, Cabañas, La Libertad, La Paz, La Unión, San Miguel, San Salvador, Santa Ana, San Vicente, Sonsonate (unknown whether native or naturalized in El Salvador; see Daniel 2001; Daniel and McDade 2014)
Odontonema tubaeforme (Bertol.) Kuntze (7): Ahuachapán, La Libertad, Morazán, San Salvador, Santa Ana, San Vicente, Sonsonate
Pseuderanthemum cuspidatum (Nees) V.M. Baum (2): Morazán, Santa Ana
Pseuderanthemum praecox (Benth.) Leonard (5): Ahuachapán, Chalatenango, Morazán, San Miguel, Santa Ana
Ruellia blechum L. (11): Ahuachapán, Cabañas, Chalatenango, La Libertad, La Paz, Morazán, San Miguel, San Salvador, Santa Ana, Sonsonate, Usulután
Ruellia donnell-smithii Leonard (5): Ahuachapán, La Libertad, San Salvador, Santa Ana, Sonsonate
Ruellia geminiflora Kunth (7): Ahuachapán, Chalatenango, Cuscatlán, Morazán, San Salvador, Santa Ana, San Vicente
Ruellia hookeriana (Nees) Hemsl. (2): Chalatenango, Santa Ana
Ruellia inundata Kunth (13): Ahuachapán, Cabañas, Chalatenango, La Libertad, La Paz, La Unión, Morazán, San Miguel, San Salvador, Santa Ana, San Vicente, Sonsonate, Usulután
Ruellia megasphaera Lindau (5): Ahuachapán, Morazán, San Salvador, Santa Ana, Sonsonate
Ruellia metallica Leonard (3): Ahuachapán, Santa Ana, Sonsonate
Ruellia paniculata L. (2): La Unión, Santa Ana
Ruellia puberula (Leonard) Tharp & F.A. Barkley (4): La Unión, San Miguel, Santa Ana, San Vicente
Stenandrium pedunculatum (Donn. Sm.) Leonard (1): Santa Ana
Tetramerium nemorum Brandegee (1): Santa Ana
Tetramerium nervosum Nees (10): Ahuachapán, La Libertad, La Unión, Morazán, San Miguel, San Salvador, Santa Ana, San Vicente, Sonsonate, Usulután
Tetramerium tenuissimum Rose (3): Ahuachapán, Cabañas, La Libertad
Thunbergia alata Bojer (3): La Libertad, San Salvador, Santa Ana
Thunbergia fragrans Roxb. (2): Santa Ana, Sonsonate

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AN INTUITIVE PHYLOGENY AND SUMMARY OF CHROMOSOME NUMBER VARIATION IN THE GOLDENROD GENUS *SOLIDAGO* (ASTERACEAE: ASTEREAE)

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ABSTRACT

An intuitive phylogeny of the goldenrod genus *Solidago* is presented. The diagram was developed over three decades as data from field observations, morphological analyses, cytology, and limited molecular studies were considered. Chromosome numbers were mapped onto the phylogeny and highlighted in various ways to show the frequencies of diploids, tetraploids, hexaploids, octoploids, nonaploids, decaploids, and duodecaploid reports. Diploid-only taxa are most frequent. High polyploid (10x-14x) individuals occur in only three species. Taxa including polypoid series are more frequent than taxa with one polypoid cytotype.

No rigorous molecular phylogeny of the goldenrod genus *Solidago* L. (Asteaceae: Astereae) has been published. The only existing phylogeny featuring broad taxonomic sampling is that of Zhang (1996), in which cpDNA restriction fragment length polymorphism data were used to reconstruct relationships among 41 *Solidago* taxa. While support for certain relationships was strong, much of the topology received modest support. One of the Zhang (1996) trees was published in Semple, Ringius, and Zhang (1999). Schilling et al. (2008) published the most recent molecular phylogeny of *Solidago* using nuclear ribosomal ITS and ETS sequence data from 21 goldenrod species and one interspecific hybrid. They reported limited interspecific sequence variation, with pairwise comparisons revealing "ITS sequence divergence of generally less than 1%, with total differences between samples of 1–10 bp." While the phylogenetic limits of the genus *Solidago* have been established by these studies, these data have done little to clarify relationships within the genus. Semple and Cook (2006) estimated the number of *Solidago* species to be ca. 100 with 77 occurring in Canada and the USA, while Semple (2016b, frequently updated) includes 120 species and 42 subspecies/varieties. This species richness and the lack of resolution provided by previous analyses highlight the need for a dataset featuring both enhanced taxonomic sampling and phylogenetic signal. With this in mind, a detailed working intuitive phylogeny is presented in an effort to provide hypotheses on evolutionary relationships.

The intuitive phylogeny of all *Solidago* species and varieties is presented in Figure 1. This is the culmination of more than four decades of work on the genus by members of my Astereae Lab and is based on (1) observations on more 20,000 *Solidago* collections, (2) field observations of more than 100 of the approximately 122 species combined with single or multi-season greenhouse observations on most of the species with known ploidy level(s), (3) chromosome number determinations from nearly 4500 individuals, (4) published and unpublished multivariate morphometric studies including nearly 3000 specimens representing all sections and subsections of the genus, (5) several unpublished cladistics studies conducted by undergraduates in the Semple Astereae Lab, (6) existing molecular phylogenies (Zhang 1996; Beck et al. 2004; Schilling et al. 2008; Peirson et al. 2013), (7) relationships indicated in Nesom (1993), and (8) numerous discussions with colleagues and students over four decades. Sixty-two Semple Astereae Lab publications that include data on *Solidago* are listed online (Semple 2016a frequently updated, goldenrods) and are not cited here separately; the

first was Brouillet and Semple (1981) and the most recent was Semple and Lopez Laphitz (2016). The intuitive phylogeny includes three species not yet described.

The phylogeny diagram has been in development for about three decades. It began in the early to mid 1980s as a large poster board with taxon names and known chromosome counts placed in a rough phylogenetic pattern. The purpose was primarily to highlight which taxa remained to be studied cytologically and also to provide a quick overview of the genus for students. The diagram was converted into a computer graphic in the early 1990s using an early version of CorelDraw™ and included in Zhang (1996). Layers were added to the diagram to highlight cytological information (Figs. 2-4) and the names of the about forty students who worked on the genus over four decades. Additional taxa were added as new names were published and changes were made to the branching topology, indicating revised hypotheses of evolutionary relationships based on new information. For example, the inclusion of *Solidago glomerata* Michx. in subsect. *Glomeruliflorae* was adopted based on the position of this taxon in Zhang (1996); Cronquist (1980) had grouped it with *S. squarrosa* and *S. puberula* Nutt. and other species placed here in subsect. *Squarrosae*. Changes in the ranks of some taxa were based on other cytological and molecular studies, e.g., Peirson et al. (2012, 2013) on subsect. *Humiles*.

Research in support of the treatment of *Solidago* for Flora North America (Semple & Cook 2006) and the English language version of the Flora of China (Chen & Semple 2011) necessitated detailed examination of nearly all *Solidago* taxa and numerous multivariate studies incorporating 35-50 traits on large numbers of specimens. Early multivariate studies include Heard and Semple (1988) and Semple et al. (1990). More recent multivariate studies include Cook et al. (2009), Lopez Laphitz and Semple (2015), Semple et al. (2015), and Semple and Lopez Laphitz (2016). These detailed studies have led to insights into relationships among species within subsections. For example, the recent addition of multivariate data on *S. gypsophila* Nesom and *S. pringlei* Fern. (Semple & Lopez Laphitz 2016) resulted in multiple changes to the topology of subsect. *Triplinerviae*; the hypothesized relationships of much of the informal *Tortifoliae* group were changed to reflect the hypothesis that *S. pringlei* is likely basal or most similar to the ancestral species for the entire group. Also, the phylogenetic position of *S. altissima* L. was changed to reflect uncertainty about whether it belongs in the *Tortifoliae* group or the *Canadensae* group within the subsection. Traits of all the infrageneric groups were included in Semple and Cook (2006) and Lopez Laphitz and Semple (2015). Inflorescence shape and branching pattern, presence or absence of basal rosettes, size differences between lower and upper leaves, leaf shape and venation, numbers and sizes of leaf margin serrations and changes in these from lower to upper stem, and phyllary shape and venation are critical features of infrageneric taxa. Multivariate studies on all infrageneric groups in *Solidago* will be published as they are completed.

The Semple Astereae Lab *Solidago* chromosome number database currently includes reports for 4466 individuals; ploidy level determinations by flow cytometry are not included. More than 2000 of these were utilized in Semple (1992), a publication summarizing chromosome count data for *Solidago* taxa by provinces and states for Canada and the USA and including a long list of references not repeated here. Additionally, Watanabe (2016 frequently updated) includes a long list of published chromosome number reports for *Solidago* along with source publications. A significant number of counts included in the Semple Astereae Lab database have yet to be published, but efforts are underway to finalize and publish all cytogeographic studies. The following chromosome numbers are known in *Solidago*: $2n$=18, 27, 36, 45, 54, 72, 90, 108, and ca. 126. The Semple Lab database includes 2723 diploid counts ($2n=9_{II}$, $2n$=18; 60.9% of all counts), along with 1022 tetraploid counts ($2n=18_{II}$, $2n$=36; 22.8% of all counts), 637 hexaploid counts ($2n=27_{II}$, $2n$=54; 14.2% of all counts), one octoploid count ($2n$=72; and 23 flow cytometry ploidy level determinations), eight decaploid counts ($2n$=90), eight duodecaploid counts ($2n=54_{II}$, $2n$=108), and one 14x count ($2n$=ca.126). Also

included are three triploid counts (2*n*=27; 0.0672%) and two pentaploid counts (2*n*=45). The number of counts for a taxon ranges from 1-471 (*S. altissima* L.). No chromosome counts have been reported for the following ten species: *S. durangensis* Nesom, *S. gypsophila* Nesom, *S. hintoniorum* Nesom, *S. orientalis* (Nesom) Nesom, S. *paniculata* DC., and *S. pringlei* from Mexico; *S. pacifica* Juz. from eastern Asia; *S. argentinensis* Lopez Laph. & Semple from South America; and *S. buckleyi* Torr. & A. Gray and *S. capulinensis* Cockerell & Andrews from the USA.

The chromosomal base number of *Solidago* is *x*=9 (Semple and Cook 2006), and Figures 2-4 summarize chromosome number variation in the context of the intuitive phylogeny. Diploids-only species are most common (Fig. 2) with 79 taxa, although this includes several dozen taxa with only 1-4 individuals sampled. Taxa exhibiting a single polyploid cytotype are rare (Fig. 3); including 11 tetraploid taxa, four hexaploid taxa, and one octoploid taxon (*S. vossii* Pringle & Loreto). There are two decaploid-only taxa (Fig. 3): *S. faucibus* Weibolt and *S. lancifolia* (Torr. & Gray) Chapm. *Solidago glomerata* is the only known duodecaploid or higher (12x-14x) taxon (Fig. 3). There are 35 taxa with more than one ploidy level reported (Fig. 4); 19 with 2*x* and 4*x*; 11 with *2x*, 4*x*, and 6*x*; and five with 4*x* and 6*x*. *Solidago* subsect. *Triplinerviae* exhibits both the largest number of taxa and the most number of multiple ploidy level taxa: *S. altissima* (471 counts), *S. gigantea* Ait. (426 counts), *S. canadensis* L. in the narrowest sense (261 counts), and *S. lepida* DC. (246 counts). Additional taxa with extensive numbers of counts include *S. nemoralis* Ait. (320 counts) in subsect. *Nemorales* and *S. rugosa* Mill. (252 counts) in subsect. *Venosae*. All of these species have been the subjects of long-term cytogeographic studies.

Several patterns emerge from mapping counts onto the intuitive phylogeny. No section or subsection of *Solidago* is only diploid or only polyploid. *Solidago* ser. *Odora* (Mackenzie in Small) Semple, *S.* ser. *Brachychaeta* (Torr. & Gray) Nesom, and *S.* ser. *Auriculatae* Semple are only known at the diploid level with multiple reports for each. Only subsect. *Thrysiflorae* comprises only diploids with one exception; two reports of tetraploids in *S. petiolaris* from Florida were in error (Semple and Cook 2004) and a third report from North Carolina has a correctly identified voucher (Semple et al. 1992). However, four of the nine taxa in subsect. *Thyrsiflorae* have no cytological data reported. All but three of the 18 taxon in subsect. *Squarrosae* are only diploid: *S. speciosa* Nutt. includes 2x and 4x individuals, *S. sciaphila* is 4x only, and the very rare *S. porteri* Small is the only 6x taxon in the subsection. All Eurasian taxa of subsect. *Solidago* are diploid, while the North American members *Multiradiatae* group include 2x and 4x or are exclusively polyploid. The taxa exhibiting the highest ploidy levels occur in only two subsections: one species in subsect. *Argutae* (Weiboldt & Semple 2003) and two species in subsect. *Glomeruliflorae* (Cook & Semple 2008). Taxa with multiple polyploid levels are more frequent (30) than taxa with a single known polyploid level (18). *Solidago* subsect. *Triplinerviae* includes the most taxa with multiple ploidy levels, which in part explains the taxonomic difficulties encountered in this group of species. It is also more intensively sampled than any other subsection, which may also account for its known cytological complexity. Finally, taxa of putative allopolyploid origin appear to be rare. The genus *Solidago* includes a large amount of morphological and cytological variation but surprisingly low levels of DNA sequence variation. This suggests relatively recent morphological and cytological divergence over a relatively short time.

ACKNOWLEDGEMENTS

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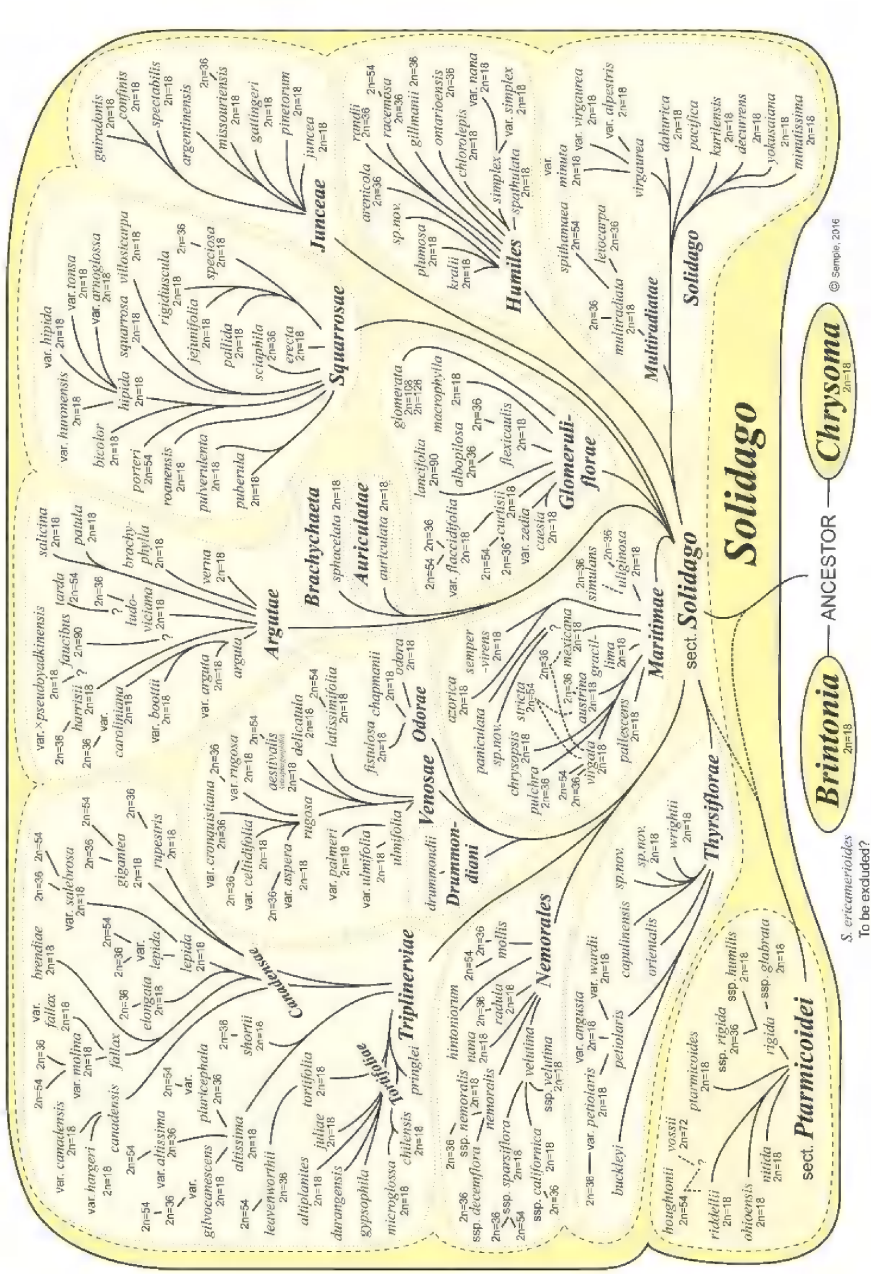

Figure 1. Intuitive phylogeny of the goldenrod genus *Solidago*.

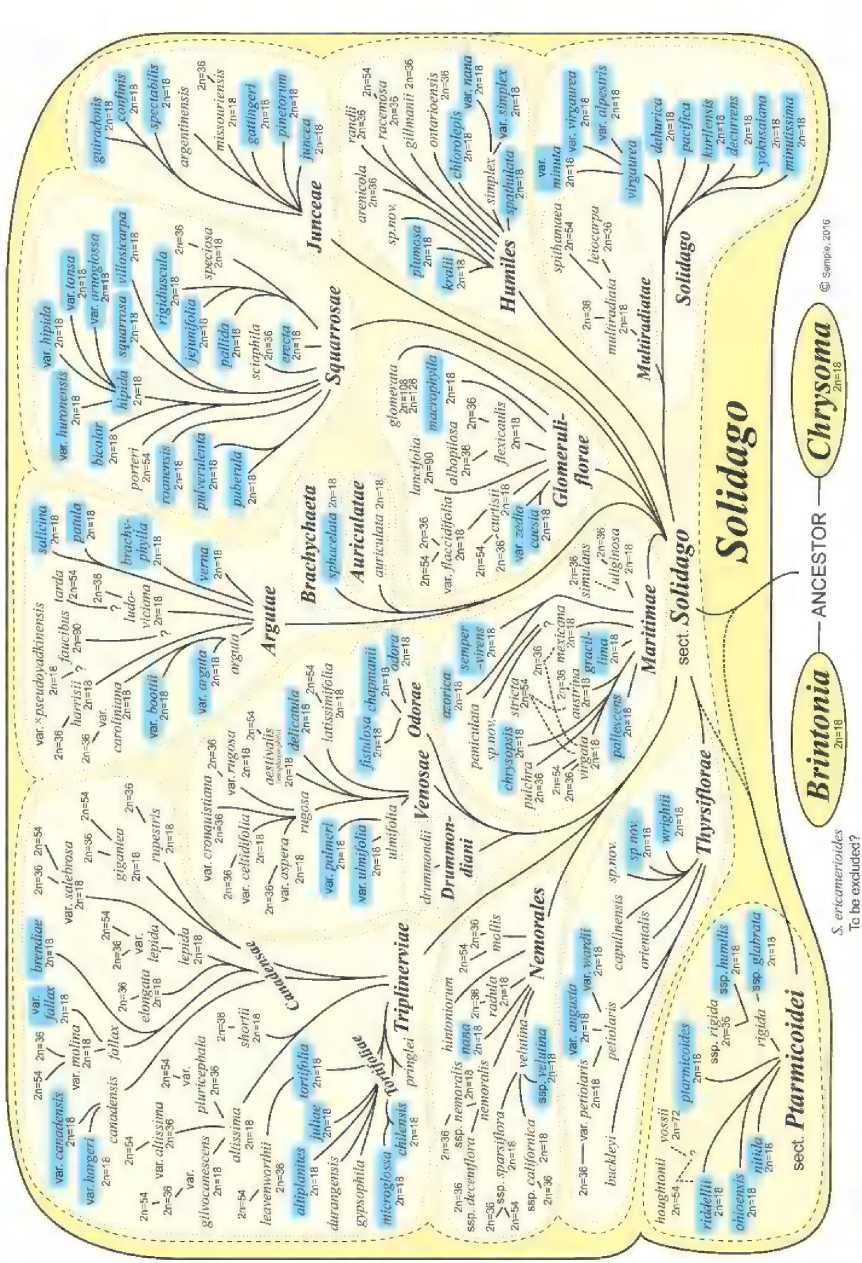

Figure 2. *Solidago* taxa known only at the diploid $2n=18$ ploidy level.

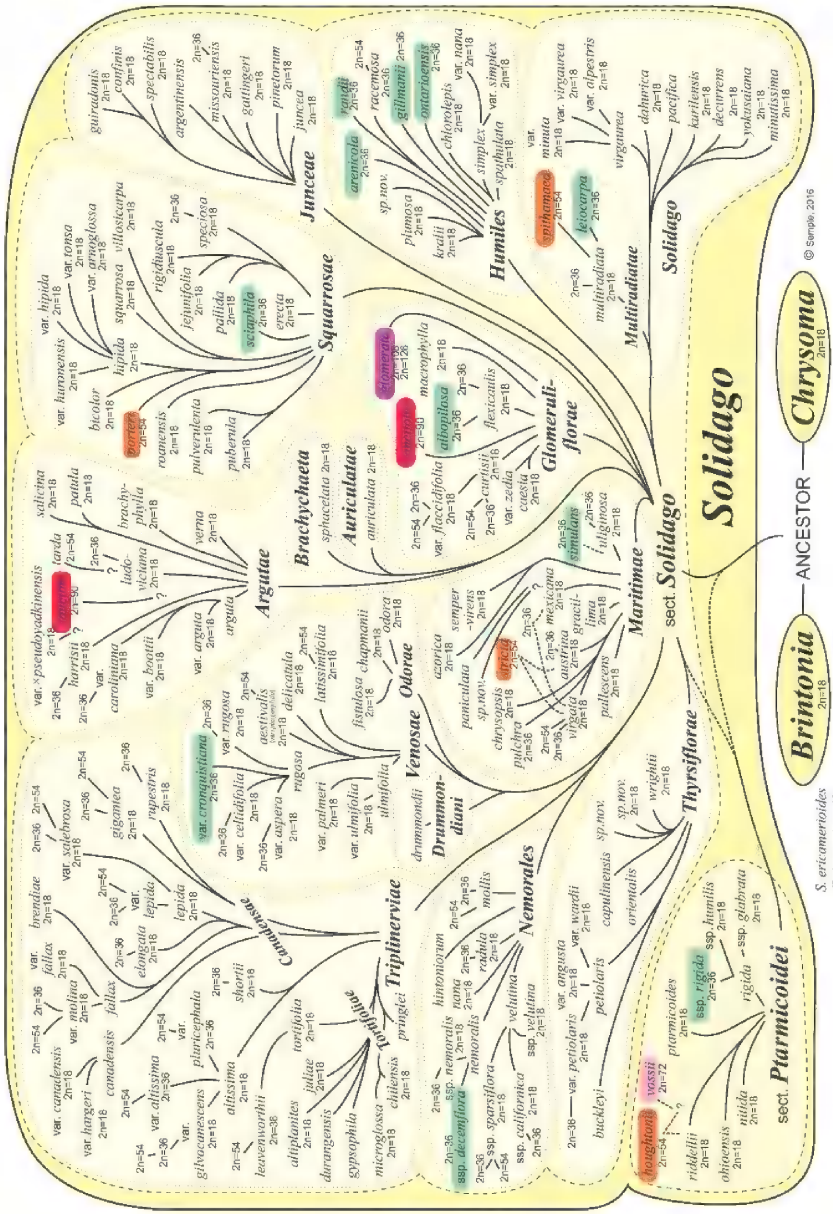

Figure 3. *Solidago* taxa known only at the tetraploid (green), hexaploid (orange), octoploid (red), decaploid (pink), or duodecaploid or higher (purple) ploidy levels.

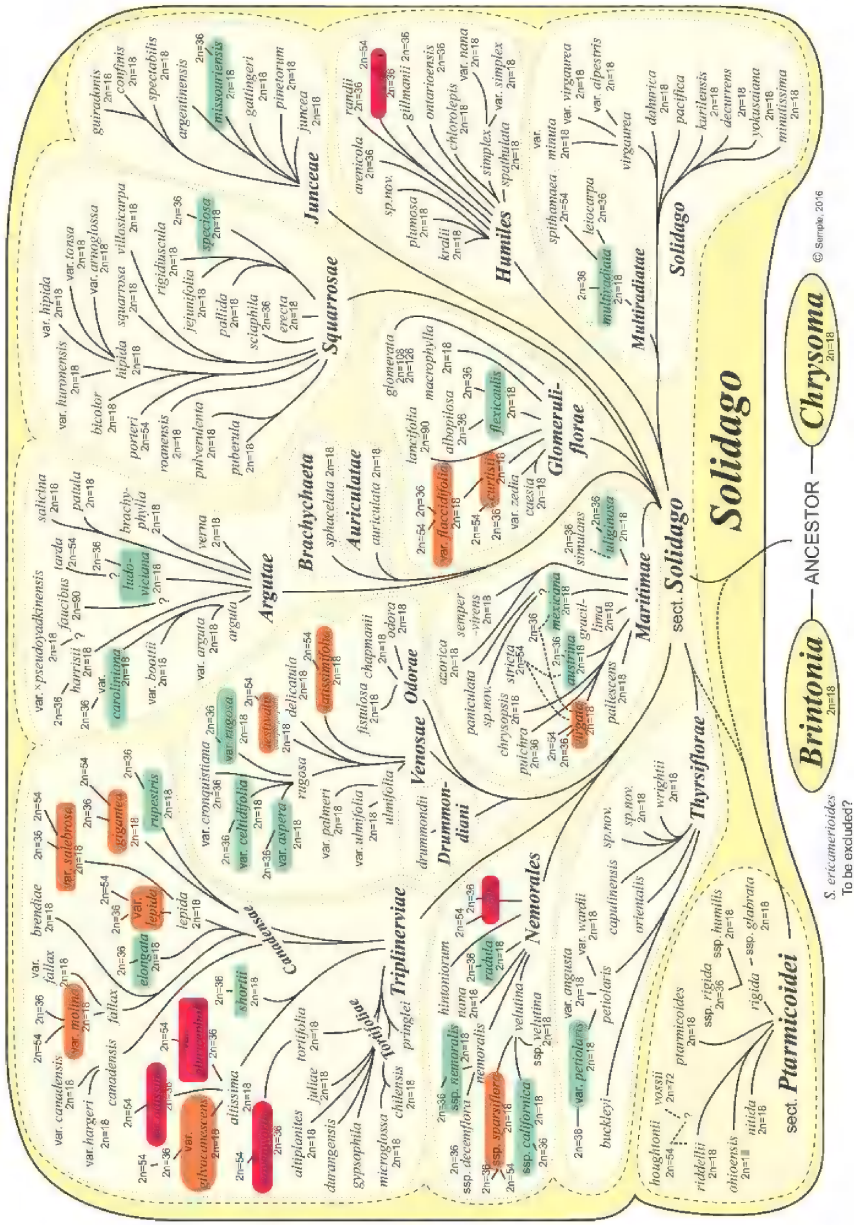

Figure 4. *Solidago* taxa known at the two or more ploidy levels: 2*x* and 4*x* (green); 2*x*, 4*x* and 6*x* (orange); 4*x* and 6*x* (red).

Mosyakin, S.L. 2016. First record of *Chenopodium ficifolium* subsp. *blomianum* (Chenopodiaceae) in North America. Phytoneuron 2016-33: 1–6. Published 11 May 2016. ISSN 2153 733X

FIRST RECORD OF *CHENOPODIUM FICIFOLIUM* SUBSP. *BLOMIANUM* (CHENOPODIACEAE) IN NORTH AMERICA

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ABSTRACT

Chenopodium ficifolium Sm. subsp. *blomianum* (Aellen) Aellen (*C. blomianum* Aellen) (Chenopodiaceae), an introduced (alien in North America) subspecies presumably native to southeastern Asia, is reported from Florida based on the specimen from MO and an image of the specimen from FLAS. Diagnostic characters, taxonomy and distribution of this taxon are discussed.

The Eurasian species *Chenopodium ficifolium* Sm. (earlier often known under a misapplied name *Chenopodium serotinum* L.; for nomenclatural details see Aellen 1941 and Uotila 1979) was reported as introduced (alien, adventive) for several states of the USA and provinces of Canada. Aellen and Just (1943) mentioned this species (as "*C. serotinum* L.") in their treatment of American taxa of *Chenopodium* and indicated that it "may be found adventive in America." In the *Flora of North America North of Mexico* (FNANM), it was reported (Clemants & Mosyakin 2003) from Quebec, Florida, Missouri, Oregon, and Pennsylvania. It is now also additionally reported from British Columbia and Ontario in Canada (NatureServe 2015) and Arizona and New York in the USA (USDA, NRCS. 2016).

However, caution has to be used for records not confirmed by herbarium specimens. Despite being a rather easily recognizable and morphologically well-characterized species, *Chenopodium ficifolium* is quite often misidentified in North American and Asian herbaria and probably overlooked in the field. Some North American specimens identified as *C. ficifolium* proved to be other taxa of *Chenopodium*; for example, a specimen from Arizona deposited at the ASU herbarium, judging from the image available online (SEINET 2016), in fact belongs to some form of the *C. album* group (not reliably identifiable from the image), but definitely not to *C. ficifolium*.

Recent dramatic rearrangements in generic placements of many taxa previously placed in *Chenopodium* (Fuentes-Bazan et al. 2012) did not affect *C. ficifolium*, which will remain in *Chenopodium* sensu stricto if the proposal (Mosyakin 2015) to conserve the name *Chenopodium* with *C. album* L. as the conserved type (and not with *C. rubrum* L., which is now placed in *Oxybasis* Kar. & Kir.) is accepted.

Several hybrids of *Chenopodium ficifolium* with other species of the genus were described and reported, mainly from Europe (Aellen 1960–1961; Dvořák 1989); they are also briefly mentioned in our FNANM treatment (Clemants & Mosyakin 2003). However, the species is normally a diploid with $2n = 18$ and its hybrids with other taxa of *Chenopodium*, especially those with different ploidy levels (for example, tetraploids of the informal groups of *C. strictum* Roth aggr., *C. berlandieri* Moq. aggr. and hexaploids of the *C. album* L. group) are considered rather improbable or at least very rare (Mandák et al. 2012). Moreover, recent molecular phylogenetic data indicated (Walsh et al. 2015) that *C. ficifolium* is phylogenetically rather distant from the main clade containing *C. album* and numerous other taxa of the genus.

Two subspecies are usually recognized within *Chenopodium ficifolium*: subsp. *ficifolium* and subsp. *blomianum* (Aellen) Aellen (Aellen 1928, 1929, 1960–1961; Mosyakin 1996; Uotila 1997, 2001a, 2001b, 2001c; Clemants & Mosyakin 2003; Zhu et al. 2003; Sukhorukov et al. 2016 etc.). These subspecies are distinguished mainly by their pericarp and seed testa sculpture (testa in subsp. *blomianum* with pits [depressions] less pronounced than in subsp. *ficifolium* and with radial furrows between pits, pit margins often curved; the "honeycombed" pattern of pericarp less evident than in subsp. *ficifolium*) and leaf shape. Clemants and Mosyakin (2003: 294) provisionally mentioned the second subspecies and reported its main diagnostic characters: "*Chenopodium blomianum* Aellen [= *C. ficifolium* subsp. *blomianum* (Aellen) Aellen] was described from Sweden based on alien plants of presumably East Asian origin (P. Aellen 1928). According to Aellen, that subspecies occurs in southern and southeastern Asia and differs from *C. ficifolium* subsp. *ficifolium* in having leaves with spreading basal lobes almost perpendicular to the central lobe and seeds with shallow elongate depressions." However, it was noted that "All North American plants of *C. ficifolium* belong to subsp. *ficifolium*." Now this information has to be updated.

During a recent visit (April 2016) to the Missouri Botanical Garden, when reviewing unidentified North American specimens of *Chenopodium* at the MO herbarium, I found a specimen collected in Florida which, judging from its morphological characters, belongs to *C. ficifolium* subsp. *blomianum*. The label information is provided below.

USA. **Florida**. Dade Co.: between Miami and Homestead, E of Princeton, E side of 112 Avenue (= Allapattah Road) ca 1 mi S of SW 248 Street (= Coconut Palm Drive), 0.6 mi S of FL Turnpike overpass, between large canal (labeled C-102) to N and small canal on N side of SW 264 Street; weedy roadside edge of palm nursery, with *Sporobolus indicus, Digitaria ciliaris, Panicum maximum, Bidens alba, Pouzolzia zeylanica, Sorghum arundinaceum, Conobea multifida, Ammannia coccinea, Mecardonia procumbens, Parthenium hysterophorus, Euphorbia graminea, E. heterophylla, Equisetum hyemale, Pentodon pentandrus, Ipomoea indica, Physalis angulata, Phyla nodiflora, Portulaca oleracea, Chamaesyce opthalmica, Hedyotis corymbosa, Lepidium virginicum, Cyperus esculentus, C. polystachyos, C. surinamensis, C. rotundus, Echinochloa colonum, Pilea microphylla, Cardamine hirsuta, Vigna luteola, Phyllanthus urinarius*; erect herb, common, 25.52303° N, 80.37193° W, 26 Sep 2008, *Abbott 25233* (MO). A scanned image of the specimen is reproduced here as Figure 1 and is available from Tropicos (2016).

A duplicate of the same collection is also deposited at FLAS (information received from the collector, J. Richard Abbott), and its image is also available online (FLAS 2016). Judging from this image, the plants from FLAS are morphologically rather uniform and identical to plants from MO.

The leaf shape of plants from Florida is typical for subsp. *blomianum*: the lateral lobes at the bases of leaves are almost perpendicular to the axis of the main central lobe. There are also other less evident and not readily verbalized leaf shape patterns that point to the southeastern Asian origin of the Florida plants (e.g., central lobes with rather large irregular teeth, as in some Asian varieties and forms of the subspecies described or recognized in Aellen 1960–1961). Judging from a few immature fruits available, the plants from Florida have rather glabrous pericarp and seed testa sculpture patterns, corresponding to the characters of subsp. *blomianum*. However, because the fruits are not completely mature and few, and the pericarp and testa sculpture are not yet clearly expressed, additional collections are needed to check these characters in fully mature material.

It is often stated that only mature seeds can be used for identification of the two subspecies of *Chenopodium ficifolium*. For example, Uotila (2001a: 33) noted under subsp. *blomianum* that "[t]he rank accepted here should be considered provisional especially because the variation is badly known in the vast other Asian areas of *C. ficifolium*. Even if there are also differences between Indian and European *C. ficifolium* in leaf shape, the variation is wide and partly overlapping, and in some cases

MISSOURI
BOTANICAL GARDEN
HERBARIUM
№ 6329848
New for the US ?
Determined by S. Mosyakin
Chenopodium ficifolium Sm.
subsp. blomianum (Aellen) Aell.
Determined by S. Mosyakin (KW)
University of Florida Herbarium (FLAS), Gainesville, Florida, USA
PLANTS OF FLORIDA
Chenopodiaceae
Chenopodium
[Phylogenetically intermixed with Amaranthaceae s.l.]
DADE COUNTY: between Miami and Homestead, E of Princeton, E side of 112 Avenue (= Allapattah Road) ca 1 mile S of SW 248 Street (= Coconut Palm Drive), 0.6 mile S of Ft. Turnpike overpass, between large canal (labelled C-102) to N and small canal on N side of SW 264 Street. Weedy roadside edge of palm nursery, with Sporobolus indicus, Digitaria ciliaris, Panicum maximum, Bidens alba, Pouzolzia zeylanica, Sorghum arundinaceum, Conobea multifida, Ammannia coccinea, Mecardonia procumbens, Parthenium hysterophorus, Euphorbia graminea, E. heterophylla, Equisetum hyemale, Pentodon pentandrus, Ipomoea indica, Physalis angulata, Phyla nodiflora, Portulaca oleracea, Chamaesyce ophthalmica, Hedyotis corymbosa, Lepidium virginicum, Cyperus esculentus, C. polystachyos, C. surinamensis, C. rotundus, Echinochloa colonum, Pilea microphylla, Cardamine hirsuta, Vigna luteola, Phyllanthus urinarius. Erect herb; common.
Lat. 25.52303°N Long 80.37193°W Datum: WGS84.
coll. J. Richard Abbott # 25233 25 September 2008
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Figure. 1. *Chenopodium ficifolium* subsp. *blomianum* from Florida (*Abbott 25233*, MO)

the races cannot be separated with certainty without seeds." However, judging from my experience with herbarium specimens (consulted mainly at HUJ, K, KW, LE, MO, NY, US and a dozen other Eurasian and North American herbaria) and plants in the field, the characteristic leaf shape patterns typical for subsp. *blomianum* almost never occur in plants of subsp. *ficifolium* (despite its wide variability), and in most cases it is sufficient for reliable identification. The plants collected in Florida (totally 7 individual plants on two herbarium sheets from MO and FLAS, 3 and 4 plants, respectively) are rather uniform in their leaf shape pattern and other observable characters; it probably indicates a single case and source of their introduction. The presence in the collection locality of numerous weedy plants (as listed on the label) native to southeastern Asia or commonly occurring there as weeds is additional evidence that the discussed taxon of *Chenopodium* was probably introduced to the place from southeastern Asia.

Precise native distribution of *Chenopodium ficifolium* subsp. *blomianum* remains insufficiently understood. In particular, Aellen (1960–1961) reported this subspecies as native to India, Nepal, China, Korea, East Siberia, Japan, and "Formosa" (Taiwan) and listed scattered localities of occasionally introduced plants in Europe. Other authors have mentioned only southern and/or southeastern Asia (Mosyakin 1996; Uotila 2001c; Clemants & Mosyakin 2003; Zhu et al. 2003) or the "Indian subcontinent" (Uotila 2001a), without further geographical details. Sukhorukov et al. (2016: 174) suggested that distribution of subsp. *blomianum* is "probably the same as type subspecies." Some authors either do not mention subspecies in *C. ficifolium* at all (Ignatov 1988; Lomonosova 1992; Sukhorukov & Kushunina 2014) or totally reject the taxonomic value of subsp. *blomianum*. For example, Dostálek (1986: 275), after studying plants from at least seven localities in North Korea, concluded that "subsp. *blomianum* (Aellen) Aellen is most likely one of the many types within the range of variability of *C. ficifolium* Smith." However, the presence of plants with characters of subsp. *blomianum* in southern and southeastern Asia (where *C. ficifolium* sensu lato is rather common) is an established fact.

Recent records of subsp. *blomianum* from southwestern Asia are more problematic. In my opinion, the densely farinose plants occurring in arid regions of southwestern Asia (probably from Pakistan and Afghanistan westward to Iraq, or probably even further westward to Egypt) related to *Chenopodium ficifolium*, usually treated in recent floras (Uotila 1997, 2001a, 2001c; Sukhorukov et al. 2016) as belonging to subsp. *blomianum*, differ in their vegetative and fruit characters from both subsp. *ficifolium* and subsp. *blomianum* and deserve recognition as a separate subspecies or probably even an independent species. The formal description of this new taxon will be published separately (Mosyakin, in preparation).

The nomenclatural citation for *Chenopodium ficifolium* subsp. *blomianum* is provided below.

Chenopodium ficifolium Sm. subsp. **blomianum** (Aellen) Aellen in Hegi, Illustrierte Flora von Mitteleuropa, ed. 2, 3(2): 624. 1960. *Chenopodium blomianum* Aellen, Bot. Not. [vol. of 1928]: 203. 1928. **LECTOTYPE** (Flora Suecica, Göteborg, bei Dampfmühle "Kvarnen Tre Lejon", 19.VII.1927, Carl Blom): (G, sheet No. 10602 of Aellen's herbarium; designated by Uotila 2001b: 97).

More collections (preferably with mature fruits) are needed to clarify the patterns of distribution of the discussed alien taxa in North America. Since *Chenopodium ficifolium* subsp. *blomianum* seems to be restricted mainly to subtropical and partly tropical regions, with only scattered occurrence of occasionally introduced plants in temperate areas, new finds of this subspecies in southern states of the USA are possible. I hope that this note will draw attention of collectors to possible new North American localities of *C. ficifolium* in general and its southeastern Asian subspecies in particular.

ACKNOWLEDGEMENTS

I am grateful to J. Richard Abbott for providing additional information about his Florida collection of *Chenopodium*, to Peter Raven, James Solomon, and Robert Magill for facilitating my research at the herbarium of the Missouri Botanical Garden (MO), and to Guy Nesom for his editorial suggestions on the manuscript.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 17. EUDICOTS: NYCTAGINACEAE TO PLUMBAGINACEAE

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ABSTRACT

A floristic and natural history account is provided for nine eudicot families as part of the vascular flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona: Nyctaginaceae, Oleaceae, Onagraceae, Orobanchaceae, Oxalidaceae, Papaveraceae, Phrymaceae, Plantaginaceae, and Plumbaginaceae. We report *Menodora scabra* seeds having mucilaginous myxotesta, which is a potential means of seed dispersal that may be related to the unusual distribution of the genus on three continents.

This is the seventeenth contribution of our flora in southwestern Arizona and includes 9 eudicot families: Nyctaginaceae (17 species, 6 genera), Oleaceae (4 species, 3 genera), Onagraceae (11 taxa, 5 genera), Orobanchaceae (4 species, 2 genera), Oxalidaceae (1 species), Papaveraceae (4 species, 2 genera), Phrymaceae (2 species, 1 genus), Plantaginaceae (13 species, 10 genera), and Plumbaginaceae (1 species, 1 genus). (*Rivina* is moved from Phytolaccaceae to Rivinaceae in a forthcoming part of this flora series.) The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1). This publication is also available open-access on the website of the University of Arizona Herbarium (ARIZ 2016).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day plants as well as fossils from packrat middens. Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). Family designations follow APG III (Angiosperm Phylogeny Group 2009) and the Angiosperm Phylogeny Website (Stevens 2012). The two non-natives in the flora area are not established as reproducing populations and are marked with double asterisks (**). Fossil specimens are indicated with a dagger symbol (†) and ones no longer present in the flora area are marked with two dagger symbols (††).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2016). All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986) and one by Bobbi Angell. Descriptions and keys pertain to taxa and populations as they occur in the flora area.

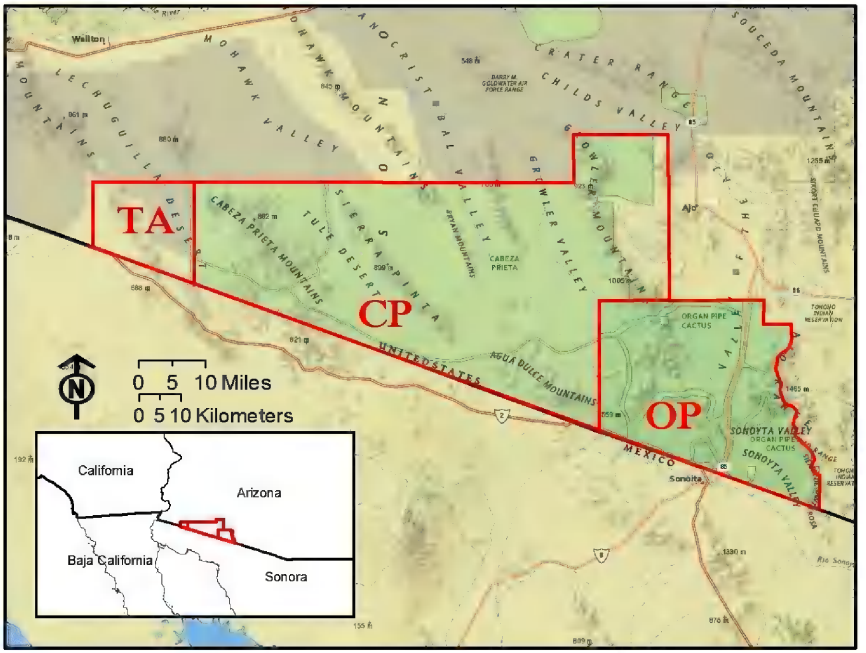

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

Table 1. Local distributions and growth forms of Nyctaginaceae, Oleaceae, Onagraceae, Orobanchaceae, Oxalidaceae, Papaveraceae, Phrymaceae, Plantaginaceae, and Plumbaginaceae. † = Modern taxa also represented by a fossil specimen(s); †† = taxa represented by fossil(s) no longer present in the flora area; ** = non-native taxa not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas. SU = summer/warm-season ephemerals; WI = cool-season/winter-spring ephemerals; NS = non-seasonal ephemerals; AP = facultative annuals or perennials; PR = perennials. Localities and growth forms in parenthesis are taxa not locally established (not reproducing) or fossils no longer present.

Taxon	Region			Growth Form				
				Ephemerals			Facultative Annuals or Perennials	Perennials
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-Seasonal		
NYCTAGINACEAE								
Abronia villosa		CP	TA		WI			
Acleisanthes longiflora		CP						PR
†*Allionia incarnata*	OP	CP	TA				AP	
Boerhavia coccinea	OP	CP	TA				AP	
Boerhavia erecta	OP	CP	TA	SU				
Boerhavia megaptera	OP			SU				
†*Boerhavia* cf. *megaptera*	(OP)			(SU)				

Boerhavia pterocarpa	OP			SU				
Boerhavia spicata	OP	CP	TA	SU				
Boerhavia triquetra	OP	CP		SU				
†*Boerhavia wrightii*	OP	CP	TA	SU				
†*Boerhavi*a sp.	(OP)							
Commicarpus scandens	OP	CP						PR
Mirabilis coccinea	OP							PR
††*Mirabilis coccinea/ M. linearis*	(OP)							(PR)
†*Mirabilis laevis*	OP	CP	TA					PR
Mirabilis multiflora	OP							PR
Mirabilis tenuiloba			TA					PR
OLEACEAE								
†*Forestiera phillyreoides*	OP							PR
††*Forestiera* cf. *pubescens*	(OP)							(PR)
***Fraxinus velutina*	(OP)							(PR)
Menodora scabra	OP	CP						PR
†*Menodora* sp.	(OP)							(PR)
ONAGRACEAE								
Chylismia arenaria		CP	TA		WI			
Chylismia claviformis ssp. *peeblesii*	OP	CP	TA		WI			
Chylismia claviformis ssp. *rubescens*	OP	CP			WI			
Epilobium canum	OP							PR
Eremothera boothii	OP	CP			WI			
Eremothera chamaenerioides	OP	CP	TA		WI			
Eulobus californicus	OP	CP	TA		WI			
Oenothera arizonica	OP	CP			WI			
Oenothera curtiflora	OP	CP		SU		NS		
Oenothera deltoides		CP			WI			
Oenothera primiveris	OP	CP	TA		WI			
OROBANCHACEAE								
Castilleja exserta	OP	CP			WI			
Castilleja lanata	OP	CP						PR
†*Castilleja* sp./spp.	(OP)		(TA)					
†*Orobanche cooperi*	OP	CP	TA		WI			
Orobanche fasciculata	OP				WI			
OXALIDACEAE								
Oxalis albicans	OP							PR
PAPAVERACEAE								
Argemone gracilenta	OP	PR					AP	
***Argemone ochroleuca*	(OP)						(AP)	
Eschscholzia californica	OP				WI			
Eschscholzia minutiflora	OP	CP	TA		WI			
PHRYMACEAE								
Erythranthe cordata	OP				WI			
Erythranthe rubella	OP				WI			
PLANTAGINACEAE								
Keckiella antirrhinoides	OP	CP						PR
Maurandella antirrhiniflora	OP	CP				NS		
Neogaerrhinum filipes	OP	CP			WI			

Nuttallanthus texanus	OP				WI			
Penstemon parryi	OP	CP	TA				AP	
Penstemon pseudospectabilis	OP	CP	TA					PR
†*Penstemon* sp.			(TA)					
†*Plantago ovata*	OP	CP	TA		WI			
Plantago patagonica	OP				WI			
Pseudorontium cyathiferum	OP	CP	TA			NS		
Sairocarpus nuttallianus	OP				WI			
Sairocarpus watsonii	OP				WI			
Stemodia durantifolia	OP							PR
Veronica peregrina	OP	CP			WI			
PLUMBAGINACEAE								
Plumbago zeylanica	OP							PR

NYCTAGINACEAE – Four-O'clock Family

The 6 genera and 15 species in the flora area are ephemerals or annuals, perennial herbs, or subshrubs. Leaves simple and opposite (sometimes subopposite in *Boerhavia*); stipules none. Flowers radial or bilateral, single or several in a cluster, subtended by one or more bracts, the bracts sometimes deciduous or sometimes forming an involucre. Perianth of one whorl (calyx) united basally, often constricted above the ovary, the upper part corolla-like; petals none. Fruits 1-seeded and indehiscent, resembling an achene or nut, often enclosed in the persistent, fleshy to hard (or leathery) base of the calyx tube, the collective structure an anthocarp, referred to here as the "fruit." Most or perhaps all those in the flora area have fruits that produce mucilage when wet.

Worldwide, mostly tropical and subtropical including deserts; 30 genera, 395 species.

1. Floral tube at least 10 cm long; mature herbage glabrous or glabrate…….…… **Acleisanthes**
1. Floral tube not more than 2 cm long (or to 6 cm in *Mirabilis multiflora*); herbage and flowering branches variously pubescent, often viscid-glandular, or sometimes glabrous.

2. Involucral bracts united into a persistent tube with 5 teeth; fruits rounded, nearly smooth. ……... **Mirabilis**
2. Involucral bracts separate, 1 to 5, sometimes reduced and/or soon deciduous; fruits not rounded and smooth—variously winged, angled, club-shaped, or grooved.

3. Flowers pink and very showy, in clusters (3) 4–5 cm wide; fruits 7–9 mm long (including the wings), with 5 wings, each wing as wide or wider than the fruit body; stigmas longer than wide (fusiform)……. **Abronia**
3. Flowers various colors including pink, solitary or in clusters less than 3.5 cm wide, or if 3.5 cm or larger then the flowers not pink; fruits not winged, or if winged then the fruits less than 5 mm long; stigmas as wide as long (capitate or peltate).

4. Stems mostly weak and trailing; flowers in clusters of 3, resembling a single flower; fruits with a single longitudinal cavity or groove formed by in-rolled wings……... **Allionia**
4. Stems erect to spreading, sometimes decumbent but not trailing; flowers often clustered but each flower conspicuously separate; fruits not grooved or with 3 to 5 furrows or grooves.

5. Fruits less than 4 mm long, without peg-like glands; ephemerals or weakly perennial herbs; herbage or flowering branches pubescent and/or glandular-sticky; plants mostly less than 1 m tall; flowers pinkish white or red-purple…… **Boerhavia**

5. Fruits 8–10 mm long, with large, peg-like sticky glands; perennials, usually semi-woody at base; stems and leaves glabrous; plants often 1 m or more tall; flowers yellow-green. ..... **Commicarpus**

Abronia – Sand verbena

North America including Mexico; 20 species of annuals and herbaceous perennials with succulent or semi-succulent herbage.

Abronia villosa S. Watson

Desert sand-verbena; *verbena de la arena*. Figure 2.

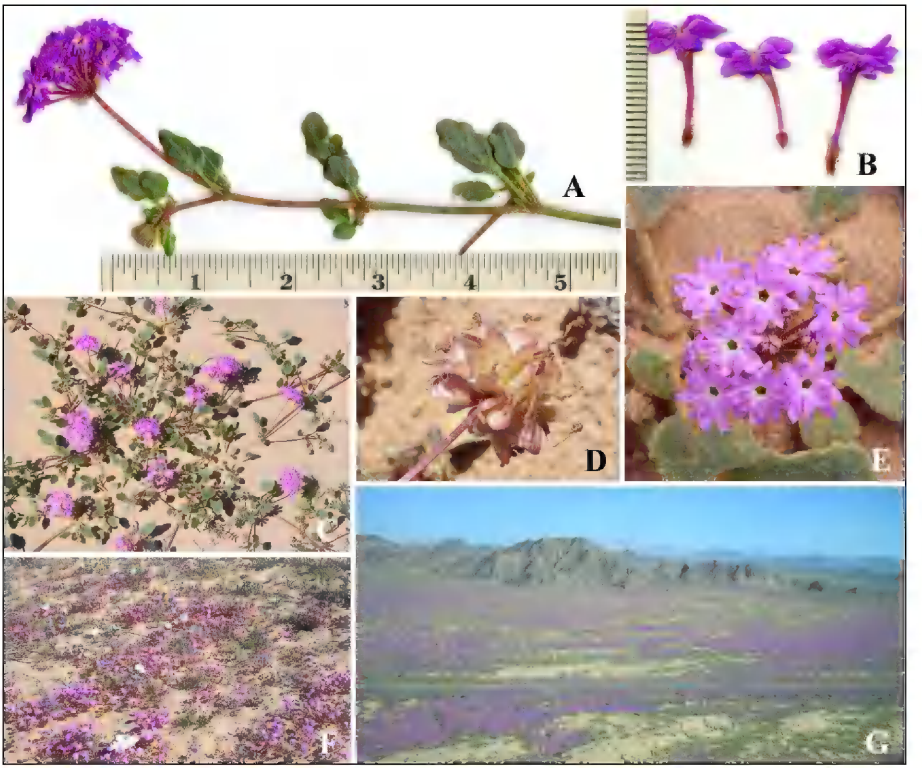

Figure 2. *Abronia villosa*. Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora: (A & B) 18 Feb 2015; (C) 16 Feb 2008. (D) Gran Desierto along Mex Hwy 2, 5 Mar 2014. (E) Dunes about 27 km SW of Sonoyta on Mex Hwy 8, 6 Feb 2014. (F) Puerto Peñasco, Sonora, 17 Feb 2008. (G) Aerial view from Mexico to the NE, with the Tule Mts in the background, 8 Feb 2005, photo by Timothy J. Tibbitts.

Spring ephemerals; highly variable in size depending upon soil moisture, the stems 15–100 cm long, the larger plants with trailing-decumbent stems. Stems and leaves semi-succulent; herbage glabrate to viscid glandular-pubescent. Opposite leaves at a node unequal in size; leaves 2.5–7 cm long, the petiole often as long as or longer than blade; blades more or less ovate, the margins mostly

crenulate to shallowly sinuate or sometimes entire. Flowers showy, very fragrant, in umbellate clusters 4–5 cm wide, subtended by 5 (4 or 6) separate bracts. Perianth 1–1.5 cm wide, pinkish purple to pale magenta or pale purple, the lobes 5 and deeply notched. Fruits winged and beaked.

Common and widespread on sand flats, dunes, and washes in Cabeza Prieta and west of the Tinajas Altas area in the Butler Mountains. Although not documented for the Tinajas Altas core area, it is common and widespread on sandy soils in the nearby areas.

Mojave and Sonoran deserts; western Arizona, northwestern Sonora, southern Nevada, southwestern Utah, southern California, and Baja California.

The Sonoran Desert populations are var. *villosa*. Variety *aurita* (Abrams) Jepson occurs in southern California and is rare in Baja California. The infraspecific taxa, however, "seem not to mean much" (Richard Spellenberg, pers. comm. to Felger, 3 May 2012).

CP: Dunes 8 mi NW of Las Playas, 15 Apr 1941, *Benson 10783*. 3 mi E of Pinacate Lava Flow, 14 Apr 1964, *Niles 348*. E of Pinacate Lava, *Simmons 14 Apr 1964* (CAB). Pinta Sands, 1 Feb 1992, *Felger 92-29*.

TA: Butler Mts, *Van Devender 27 Mar 1983*.

Acleisanthes

Southwest USA and northern Mexico, mostly Chihuahuan and Sonoran desert regions, with 16 species, and one species endemic to Somalia in northeast Africa.

Acleisanthes longiflora A. Gray

Angel's trumpets. Figure 3.

Suffrutescent perennials from thickened, knotty roots; the herbage frost-sensitive. Stems slender and brittle, erect-ascending to sometimes prostrate. Youngest herbage with very short white hairs (more scurfy than hair-like); mature herbage essentially glabrous or glabrate, or lower leaf surfaces often with thinly distributed small, appressed hairs. Mature stems and leaves often glaucous (shiny white waxy). Leaves often 1.5–3.5 cm long, held upright, opposite leaves at a node nearly equal, petioled, the blades triangular to lanceolate, moderately thickened, the margins entire to wavy. Flowers nocturnal, the perianth pure white with a slender tube 10.5–13.5 cm long, and a 5-lobed limb often 1.8 cm wide. Anthocarps narrowly cylindrical-ellipsoid and shallowly 5-ribbed or angled. Sometimes also producing short, cleistogamous flowers (non-opening and self-fertilizing). Leafy and flowering in early March depending on soil moisture and especially with summer rains.

Agua Dulce Mountains on north- and south-facing slopes in talus-like fractured metamorphic rock. Also highly localized in nearby northwestern Sonora where it occurs on granitic hills and mountains.

Sonoran and Chihuahuan deserts and Tamaulipas thornscrub; southeastern California to Texas, and northern Mexico from Sonora to Durango, Coahuila, and Tamaulipas.

CP: Vicinity of Agua Dulce Pass, 13 Jun 1992, *Felger 92-564*.

Figure 3. *Acleisanthes longiflora*. Sierra Los Tanques, 11 km SW of Sonoyta, Sonora, on Mex Hwy 8: (A, B, & D) 7 Sep 2014; (C, E & F) 27 Mar 2010, about 6:00 a.m.

Allionia

Southwest USA to South America and the West Indies; 2 species (as interpreted here).

Allionia incarnata Linnaeus

[*A. incarnata* var. *nudata* (Standley) Munz. *A. incarnata* var. *villosa* (Standley) Munz]

Windmills, trailing four o'clock. Figure 4.

Short-lived perennials and also flowering in the first season as facultative ephemerals, with a stout taproot, and dying back to the roots during drought, growing and flowering non-seasonally (mostly April to November) except during colder weather and extreme drought; glandular hairy and sticky viscid throughout except the flowers, often with sand sticking to the herbage. Stems slender and becoming prostrate-trailing with forked branching, sometimes reaching more than 1 m long but usually much shorter. Leaves petioled, variable, the larger ones (1.7) 2.5–7.2 cm long, the blades usually ovate; opposite leaves of a pair unequal in size.

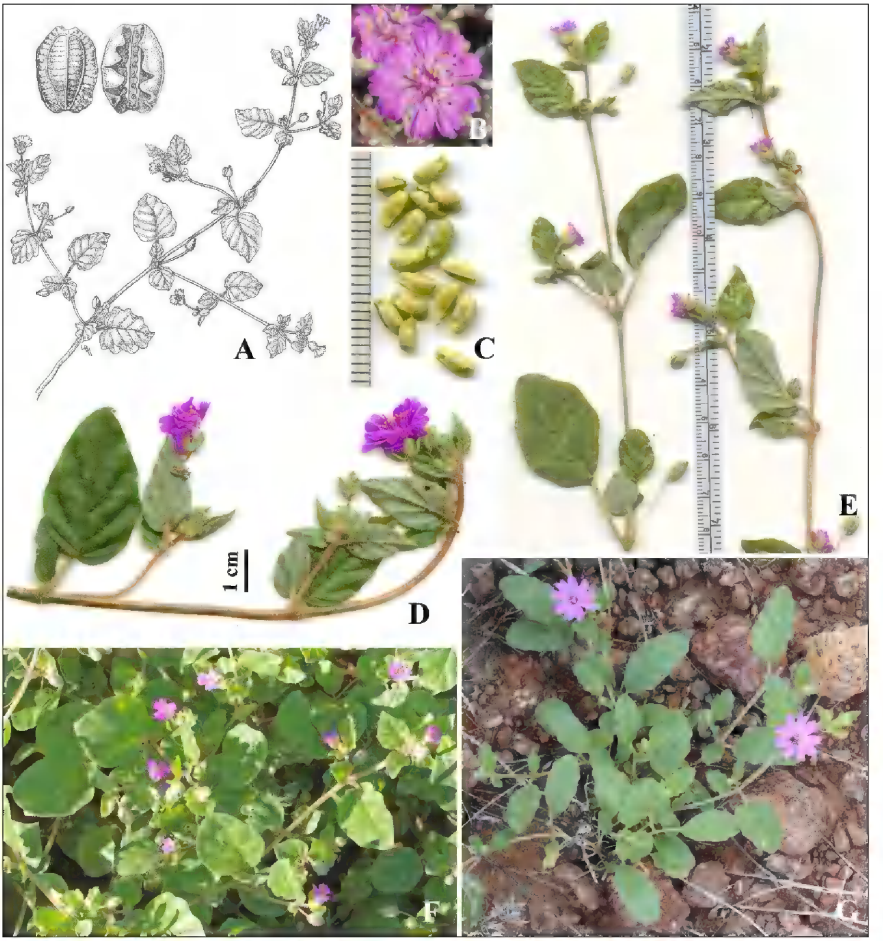

Figure 4. *Allionia incarnata*. (A) By Lucretia Breazeale Hamilton. (B) Saddle between Boulder and Arch canyons, 14 May 2006. (C) Diablo Canyon, 30 Sep 2014. (D) Darby Arroyo near Hwy 85, 28 Jul 2014. (E) Hwy 85 near N boundary of Organ Pipe, 17 Aug 2008. (F) Daniels Arroyo near Charlie Bell Road, 24 Aug 2014. (G) Alamo Canyon, 9 Sep 2013.

Flowers in 3s, the easily separated flowers resemble a single flower, the trios axillary on slender peduncles. Each flower in the trio subtended by a sepal-like bract; perianth of each flower forming a wedge-shaped third of the cluster, showy, bright lavender-pink; perianth trios often 1–2 cm wide; flower size and peduncle length highly variable. Stamens exserted, the filaments and style lavender-pink, the anthers yellow. Flowers opening in the early morning and wilting by late morning on hot days. Fruits 3–4.8 mm long, tan, firm, ellipsoid and sausage-shaped, one side convex, the other side with a pair of broad, in-rolled wings forming a deep cavity, the wings toothed or not; all 3 fruits in the cluster often developing; the fruits exude copious mucilage when wet. The fruits are

unique among Sonoran Desert nyctages in being bilaterally rather than radially symmetrical. Larger- and smaller-flowered plants occur in the flora area.

Widespread across the flora area; in many habitats including gravelly floodplains, washes, canyons, flats, and rocky slopes. It has been a member of the local flora for at least 8600 years.

Southwestern North America to Argentina and Chile; with larger- and smaller-flowered forms and much variation in fruit ornamentation. Three weakly differentiated varieties are generally recognized (Spellenberg 2003; Turner 1994). Variety *villosa*, distinguished in having larger flowers and slightly larger fruits, is reported for the flora area. Walter Fertig noted, "I've wondered about some of the putative variability in *Allionia*. I have seen large flowered plants growing in among small-flowered ones. They look striking in the field, but much less so when pressed and the only real difference seems to be flower size. I tend towards being more generous with polymorphism perhaps than some taxonomists."

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Sonoyta road 1 mi S of N entrance, *McDougall 10 Apr 1941*. Armenta Well, *Warren 16 Nov 1974*. Aguajita Wash, 14 Sep 1988, *Felger 88-403*. †Alamo Canyon, seeds, 1150 & 8590 ybp. †Puerto Blanco Mts, seeds, 3440 ybp.

CP: S of Las Playas Lava Field, 10 Apr 1978, *Reeves 6767* (ASU). Pinacate Lava flow, 21 Mar 1992, *Telewski & Harlan 72*. Agua Dulce Pass, 12 & 14 Jun 1992, *Felger* (observation). Childs Mt, 2845 ft, 18 Aug 1992, *Felger* (observation). Bates Well Road at ORPI boundary, 14 Sep 1992, *Felger 92-678*.

TA: Tinajas Altas, bajada, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-23*.

Boerhavia – Spiderling, *juanipili, juanimipili*

Summer ephemerals and one herbaceous perennial in the flora area; usually branched from the base and pubescent with glandular-sticky areas at least on the stems. Leaves opposite or subopposite, usually petioled, the opposite leaves of a pair often unequal in size. Inflorescences of long, slender branches, and small bracts below the flowers. Flowers open in the early morning and wilt with daytime heat—stamens collapsing onto the stigma, apparently self-fertilizing if the flower has not been cross-pollinated. Perianth white, pink, purple, or reddish. Fruits obovoid or obpyramidal, 3–5-angled and/or grooved (furrows or sulci), exuding mucilage when wet and adhering when dry.

The Seris have prepared certain young *Boerhavia* plants as greens (Felger & Moser 1985).

Warm-temperate, arid and tropical regions worldwide; 40 species. "At the species level, there is variation that is often difficult to treat taxonomically, especially among annuals of the Sonoran Desert....Many species probably are highly autogamous (Spellenberg 2000)" (Spellenberg 2003: 17–18).

1. Perennials or annuals; flowers dark red-purple; fruits sticky and densely pubescent with glandular hairs..... **Boerhavia coccinea**
1. Hot-weather ephemerals; flowers white or pale pink; fruits glabrous, not sticky.

2. Flowers in umbellate or sub-umbellate clusters.

3. Fruits angular but not winged (or not prominently winged), 5-angled.

4. Fruits (2.9) 3.4–4.7 mm long, often with a stipe-like base..... **Boerhavia erecta**
4. Fruits 2–2.9 (3.2) mm long, the base sessile..... **Boerhavia triquetra**

3. Fruits prominently winged, 3–5 angled.

5. Fruits 5-winged, the fruit body smooth..... **Boerhavia megaptera**
5. Fruits 3- or 4-winged, the body coarsely and transversely rugose ("corrugated").
..... **Boerhavia pterocarya**

2. Flowers on elongated racemose branches.

6. Fruits 2.1–2.5 (2.7) mm long, slender (narrowly obovate), 5-angled or ridged, the furrows variously open to closed, mostly narrow to nearly closed..... **Boerhavia spicata**
6. Fruits 2–3 mm long, chunky (broadly obovate), all or most fruits 4-angled, the furrows broad, open, and roughened inside..... **Boerhavia wrightii**

Boerhavia coccinea Miller
[*B. caribaea* Jacquin]
Scarlet spiderling. Figure 5.

Short-lived herbaceous perennials growing with warm to hot weather and also flowering in the first season, openly branched and sprawling, sometimes reaching 1–1.5 m across, the roots thickened. Stems densely hairy, glabrate, or glabrous. Reproductive in warmer months with sufficient soil moisture. Inflorescences diffuse and much branched, the branches very slender, glabrous or glandular hairy; flowers in sub-umbellate clusters at ends of thread-like branchlets. Flowers bright red-purple, remaining open longer in the day than the other boerhavias in the region. Fruits 2.8–3.5 mm long, very sticky with exudate from glandular hairs; immature fruits rounded, the mature ones narrowly obovoid, prominently ribbed (the ribs raised and smooth), the tip rounded.

Roadsides and other disturbed habitats, washes, and near waterholes, and sometimes in natural habitats including canyon bottoms.

Southern USA to South America and the Caribbean; native in the New World and widespread and weedy in warm regions worldwide.

OP: Walls Well, *Nichol 28 Apr 1939.* W of Bates Mts, 31 Mar 1978, *Bowers 1165* (ORPI). Ajo Mt Loop Road 2.3 mi E of Visitor Center, 9 May 1985, *Van Devender 85-114.*
CP: Childs Mountain, 18 Aug 1992, *Felger 92-637.*
TA: Tinajas Altas, near lower tinaja, 15 Jun 1992, *Felger 92-609.*

Boerhavia erecta Linnaeus
Spiderling; makkumĭ ha-jeved. Figure 6.

Summer-fall ephemerals; herbage glabrous or with minute hairs, the flowering branches with glandular-sticky bands. Stems, petioles, and sometimes leaf blades with moderately to densely glandular patches. Stems mostly 20–100 cm long. Leaf blades ovate to narrowly lanceolate. Flowers white or pale pink, 2 to several in umbellate or sub-umbellate clusters with at least some of the pedicels attached well below others. Fruits (2.9) 3.4–4.7 mm long, 5-angled, often bright green to red-green when fresh, often sub-stipitate (base of fruits weakly differentiated into a narrowed and nearly terete stalk), the tip blunt (truncated). The plants are often more robust than those of *B. triquetra.*

Mostly in the larger washes and drainageways in valleys and major canyons; often locally abundant.

Warm regions of Latin America and southern USA, and weedy in the Old World.

OP: 2 mi SE of Walls Well, 30 Aug 1945, *Gould 3214.* Alamo Canyon, 17 Oct 1987, *Baker 7559* (ASU, ORPI). Aguajita Wash, with var. *intermedia* [= *B. triquetra*, *88-413*], 14 Sep 1988, *Felger 88-424.*

CP: 4 mi W of Papago Well Road gate, *Simmons 1 Oct 1963.* San Cristobal Wash, road from Bates Well, 14 Sep 1992, *Felger 92-692.* Road from Bates Well 2.4 mi SW of Refuge boundary, 15 Sep 1992, *Felger 92-745.*

TA: Coyote Water, 25 Oct 2004, *Felger 04-28* (ARIZ, ASU).

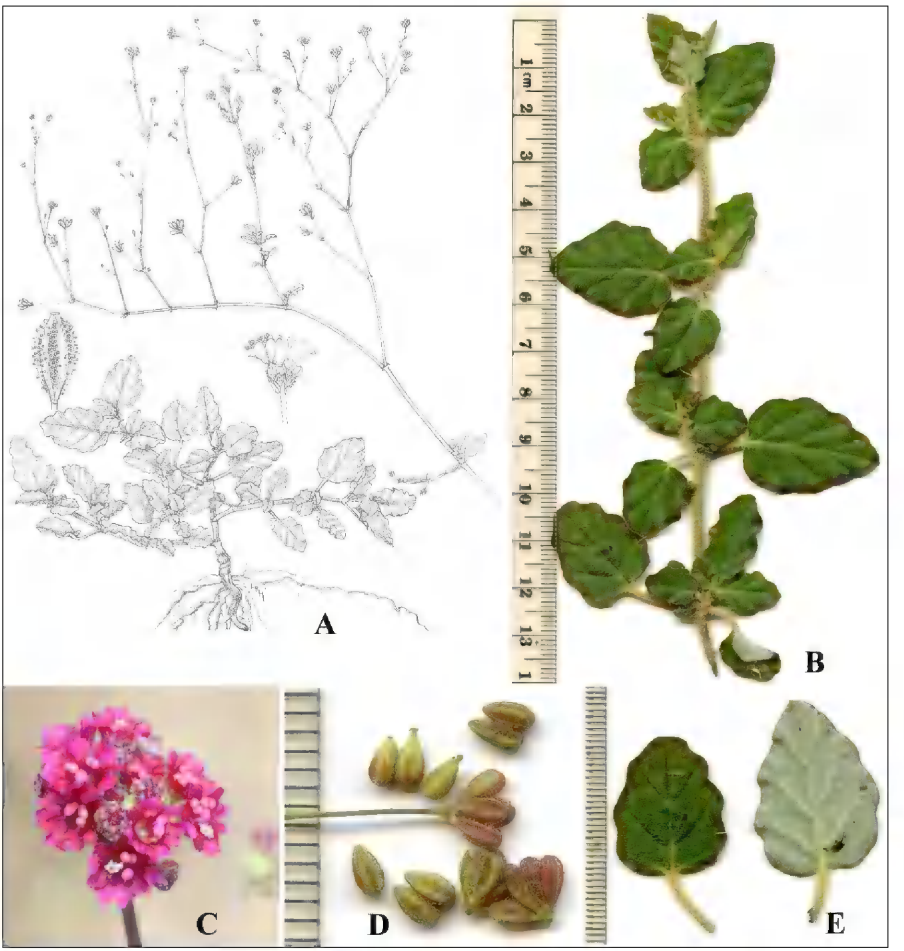

Figure 5. *Boerhavia coccinea.* (A) By Lucretia Breazeale Hamilton. (B & E) Estes Canyon, 17 May 2015. (C) Valley of the Ajo, 6 Oct 2012. (D) Ajo, 23 Aug 2014.

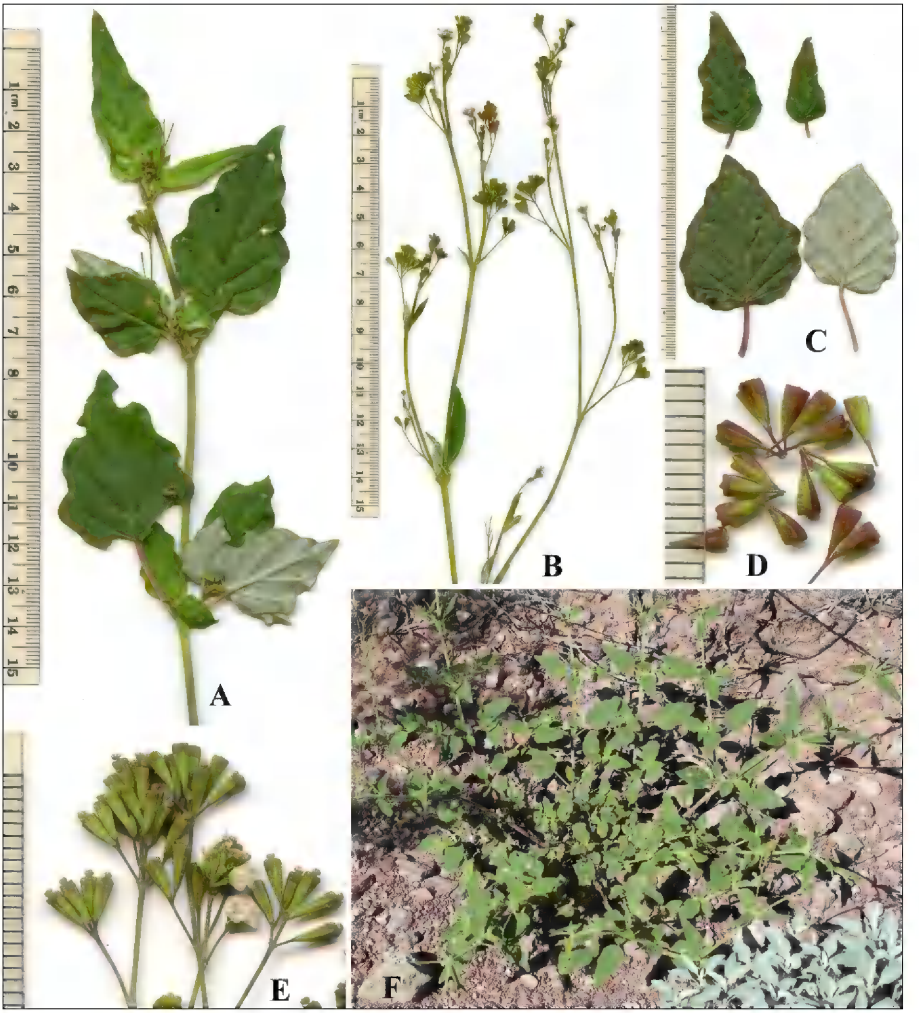

Figure 6. *Boerhavia erecta*. (A) Bates Well Road, N of Bates Well Ranch, 4 Aug 2014. (B) Cuerda de Leña, 4 Aug 2014. (C & D) Kuakatch Wash at Hwy 85, 11 Aug 2014. (E) E of Why on Hwy 86 near mile 62, 1 Aug 2014. (F) Arch Canyon, 26 Aug 2014.

Boerhavia megaptera Standley
Large-winged spiderling. Figure 7.

Summer ephemerals; herbage minutely hairy, the flowering branches with glandular sticky bands. Flowers in small umbellate clusters, white or pale pink. Fruits broadly obconic, 3.2–3.8 mm long, prominently 5-winged, the wings about as wide as the body, the fruit body smooth.

Locally in the Ajo and Diablo mountains. This or a similar species was in the Ajo Mountains up to at least 13,500 years ago.

This species is known only from southern Arizona, northward and eastward from the Ajo Mountains. *Boerhavia megaptera* is "part of or very closely related to" the *B. triquetra* complex (Spellenberg 2007: 874).

OP: Bull Pasture Trail, 5 Nov 1977, *Bowers 954.* Arch Canyon, 3000 ft, *Rutman 14 Aug 1998* (ORPI); Shady slope N of the Arch, with *Selaginella*, 26 Aug 2014, *Rutman 20140826-5.* Diablo Mts, grassy slope, 12 Sep 2013, *Rutman 20130912-6.* †*B.* cf. *megaptera*: Alamo Canyon, fruits, 9570 ybp; Montezuma's Head, fruits, 13,500 ybp.

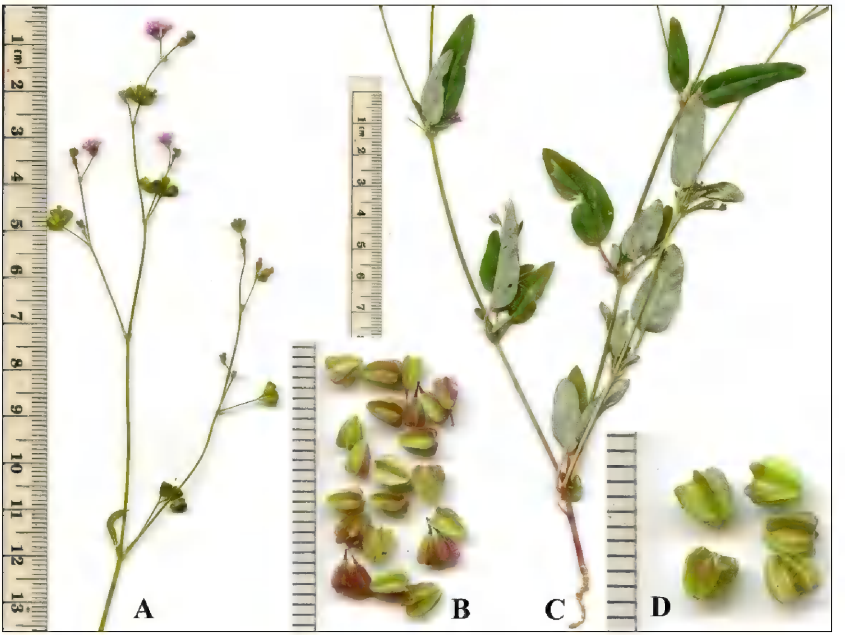

Figure 7. *Boerhavia megaptera.* (A, C, & D) N-facing slope with *Selaginella*, Arch Canyon Trail, 26 Aug 2014. (B) Wash crossing near N end of Ajo Mountain Drive, Diablo Mts, 30 Sep 2014.

Boerhavia pterocarpa S. Watson
Wing-fruit spiderling. Figure 8.

Summer ephemerals; herbage pubescent with minute hairs, the flowering branches without glandular sticky bands. Flowers in small umbellate clusters, white or pale pink. Fruits 2.9–3.4 mm long, broadly obpyramidal with a stipe-like base, and unique among the boerhavias in the region with 3 or 4 prominent broad wings and the fruit body coarsely and transversely rugose (corrugated).

Known from a single record in the flora area. Southern Arizona and adjacent northern Sonora, and rare in southwestern New Mexico.

OP: Old fields at Armenta Well Ranch, 1700 ft, 13 Sep 1978, *Bowers 1533* (ORPI).

Figure 8. *Boerhavia pterocarpa*. Bajada 6 miles W of Little Florida Mts, NM, 26 Aug 2009, photo by Gene Jercinovic (SEINet).

Boerhavia spicata Choisy, 1849
[*B. spicata* Choisy var. *palmeri* S. Watson, 1889. *B. palmeri* S. Watson, 1889, not *B. palmeri* S. Watson, 1883. *Senkenbergia coulteri* Hooker f., 1880. *B. coulteri* (Hooker f.) S. Watson, 1889. *B. coulteri* var. *palmeri* (S. Watson) Spellenberg, 2002. *B. watsonii* Standley, 1909.]
Spiderling. Figure 9.

Summer-fall ephemerals. Stems often 30–50+ cm long. Leaves often 3–6+ cm long, the blades ovate to ovate-deltate. Herbage moderately glandular-sticky, the flowering branches conspicuously glandular-sticky, sticking to shoes, socks, and pant legs. Flowers on slender, spicate branches; bracts beneath flowers deciduous. Flowers white or pale pink. Fruits 2.1–2.5 (2.7) mm long, narrowly obovoid, the furrows nearly closed to open and roughened (rugulose) inside, the ridges 5, broad, rounded or broadly obtuse (more angled when immature), the tip rounded.

Widespread and often very common across the region in various habitats, sandy to rocky soils, washes, bajadas, flats, and rocky slopes.

Southeastern California to western Texas and southwestern Utah, Sonora, Sinaloa, Chihuahua, and the Gulf side of the Baja California Peninsula.

Several taxa of annual (ephemeral) boerhavias with spicate inflorescences in the Sonoran Desert form a taxonomically difficult group and are variously interpreted, with *B. coulteri* and its two varieties often recognized as distinct from *B. spicata* (e.g., Spellenberg 2003). "These taxa are often sympatric, either in mixed populations, or with *B. coulteri* var. *palmeri* inhabiting slightly drier sites. Though most specimens are easily placed in one variety or the other, they intergrade and hybridization is likely" (Spellenberg 2003: 26). If *B. spicata* and *B. coulteri* are maintained as distinct species, then the southwest Arizona population would be *B. coulteri* var. *palmeri*.

OP: Armenta Well, *Warren 16 Nov 1974*. Aguajita, wash, 14 Sep 1988, *Felger 88-415*. 1 mi E of Senita Basin road, *Wirt 25 Jul 1990*. W of Cuerda de Leña and S of N boundary of park, loamy *Larrea* flat where water settles, *Rutman 7 Oct 2006*.

CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-656*. Bates Well Road at E Refuge boundary, 18 Aug 1992, *Felger 92-676*. E Pinta Sands, 15 Sep 1992, *Felger 92-752*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-29* (ARIZ, ASU).

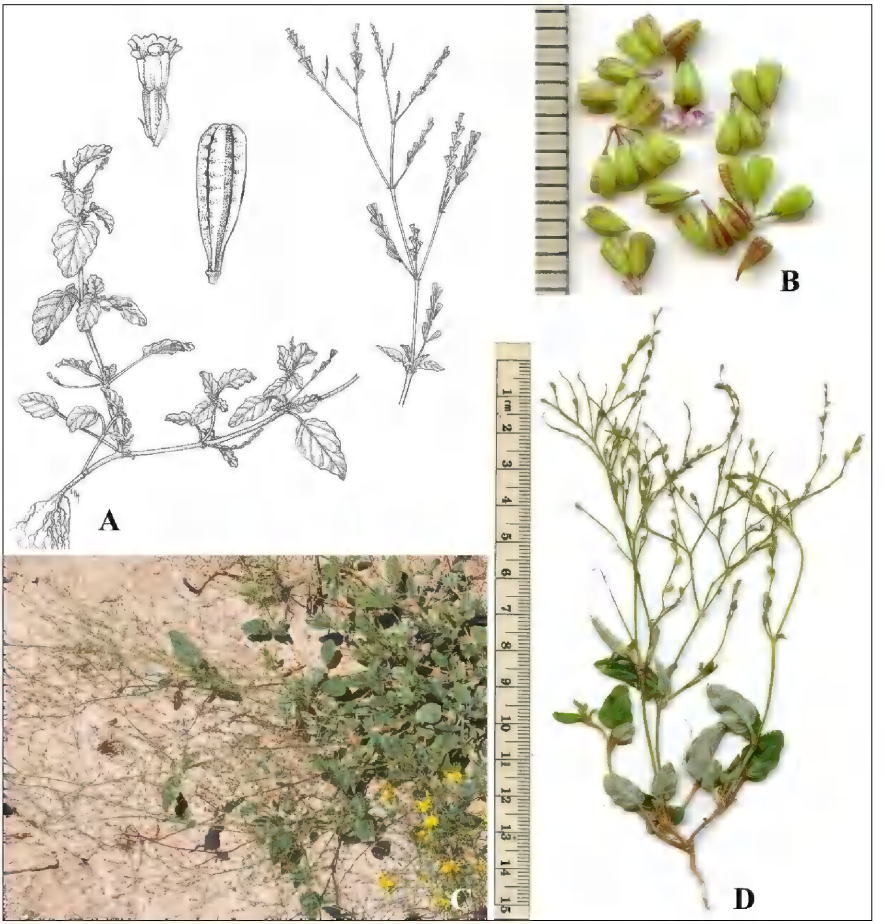

Figure 9. *Boerhavia spicata*. (A) By Lucretia Breazeale Hamilton. (B) Kuakatch Wash at Hwy 85, 11 Aug 2014. (C) Growler Wash near Bates Well, 30 Sep 2006. (D) Cuerda de Leña, 4 Aug 2014.

Boerhavia triquetra S. Watson
[*B. intermedia* M.E. Jones. *B. triquetra* var. *intermedia* (M.E. Jones) Spellenberg. *B. maculata* Standley]
Spiderling. Figure 10.

Summer ephemerals. Leaves oblong to narrowly lanceolate, mostly 1–3 cm long, paler beneath, often glandular-punctate. Flower clusters umbellate or sub-umbellate; perianth whitish or pale pink. Fruits 2–2.9 (3.2) mm long, 5-angled, the angles or ridges acute, the intervening grooves (sulci) open, coarsely and deeply rugose, the fruit tip blunt (truncate); fruit lacking a stipe-like base. Distinguished from *B. erecta* by the smaller fruits without a stipitate base, the fruits generally duller, not as dark green when fresh, and browner at maturity, and the plants usually more delicate.

Widespread in Organ Pipe and Cabeza Prieta in various habitats including washes, bajadas, canyon, and rocky slopes.

Southeastern California to Texas and northern Mexico.

Boerhavia triquetra var. *intermedia* and *B. triquetra* var. *triquetra* are narrowly defined and both may intergrade and occur intermixed, including at the type locality for *B. triquetra* in Baja California. *B. maculata*, from southern Sonora and Sinaloa, apparently only differs in size from *B. triquetra* var. *triquetra*. *Boerhavia triquetra*, published in 1889, has priority over the other taxa. (Murdock 2012; Spellenberg 2003, 2007).

OP: Dos Lomitas, *Warren 11 Aug 1975*. Diablo Mts, wash, along Ajo Mt Drive, 12 Sep 2013, *Rutman 20130912-13*. Aguajita Wash, abundant, 14 Sep 1988, *Felger 88-413* [with *B. erecta*, *88-424*].
CP: N side of Tule Mountains, 2 Feb 1992, *Felger* (observation). Las Playas, 28 Nov 2001, *Felger 01-572*.

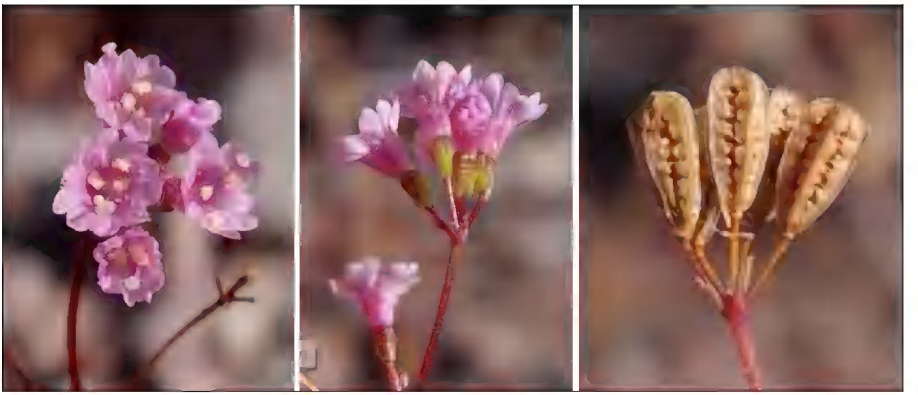

Figure 10. *Boerhavia triquetra*. Bahía San Pedro, Sonora, 12 Dec 2014, photos by Sue Carnahan.

Boerhavia wrightii A. Gray
Large-bract spiderling. Figure 11.

Summer-fall ephemerals, sometimes persisting until freezing weather; highly variable in size, flowering as small as 10 cm high, although the plants often rather robust and sometimes reaching 1 m in height and 1.5+ m in width. Herbage extremely glandular-sticky throughout, including the flowering branches. Larger (lower) leaves often 2.5–7.5 cm long, the blades ovate to oblong or lanceolate, darker green above, the margins crenulate. Inflorescences of glandular-sticky racemose or sometimes spicate branches. Flowers pale pinkish white to pink. Flowers and fruits subtended by deciduous or semi-persistent bracts often ⅔ as long as or longer than the fruits. Fruits broadly ovoid, relatively short, squat, and chunky, 2–3 mm long, 4 (5)-angled, the angles sharp-edged, the furrows open, broad, and often roughened inside.

Sandy to rocky soils in many habitats; nearly ubiquitous and often abundant across the flora area. It has been part of the local flora for at least 21,800 years.

Southeastern California to western Texas, southwestern Utah, and southern Nevada to northern Sonora, Chihuahua, and northeastern Baja California.

OP: Alamo Canyon, *Van Devender 31 Aug 1978.* Armenta Ranch, old fields, 13 Sep 1978, *Bowers 1530.* Aguajita Wash, 14 Sep 1988, *Felger 88-412.* 1.5 mi W of State Route 85 and 0.15 mi S of Armenta Ranch Road, 30 Sep 2006, *Rutman 20060930-14.* †Montezuma's Head, fruits, 13,500 & 21,840 ybp. †Puerto Blanco Mts, fruits, 1910 to 9720 ybp (5 samples).

CP: Papago Well, Camino del Diablo, 27 Oct 1937, *Gentry 3505* (DES). Childs Mt, 2845 ft, 18 Aug 1992, *Felger 92-638.* Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-655.* Bates Well Road at E Refuge boundary, 14 Sep 1992, *Felger 92-677.* 1 mi E of Namer's Grave, 15 Sep 1992, *Felger 92-765.*

TA: Tinajas Altas, 26 Oct 2003, *Felger* (observation). Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-08.* Coyote Water, 25 Oct 2004, *Felger*, observation. †Butler Mts, fruit, 8160 ybp.

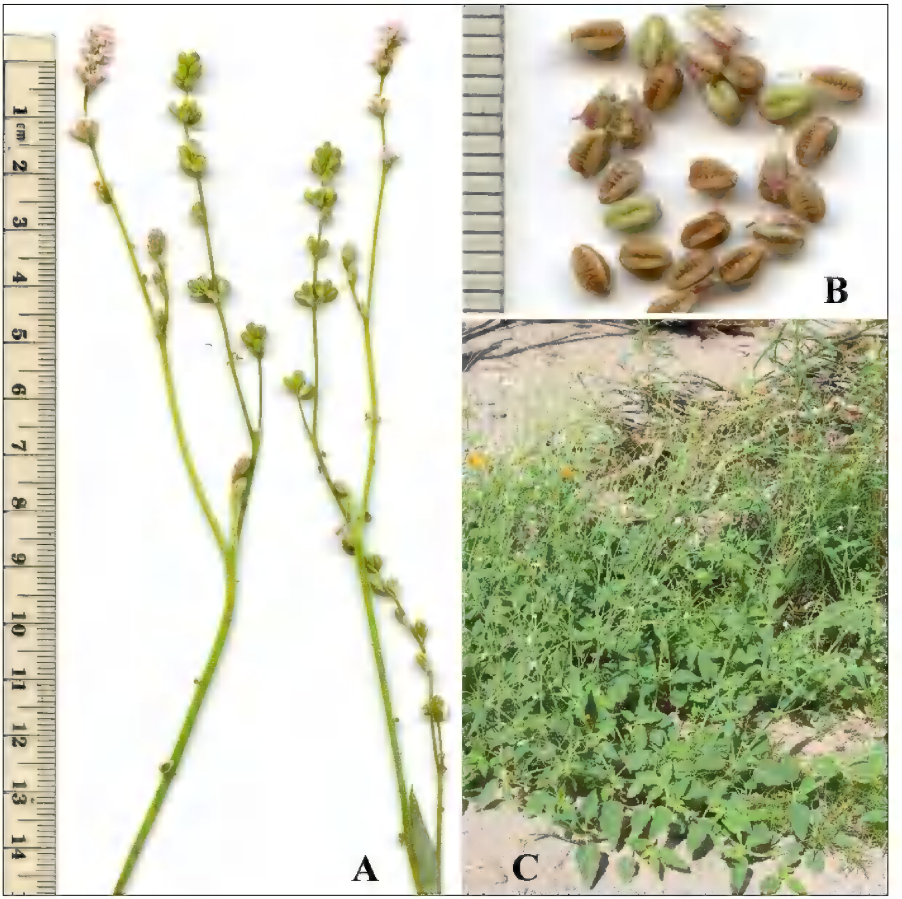

Figure 11. *Boerhavia wrightii.* (A & B) Bates Well Road, N of Bates Well, 4 Aug 2014. (C) Gunsight Wash at Why, 2 Aug 2014.

†**Boerhavia** sp.

OP: †Puerto Blanco Mts, fruits, 980 to 8790 ybp (4 samples).

Commicarpus

Americas, Africa, Australia, and Eurasia; 35 species. Although *Commicarpus* is sometimes placed within *Boerhavia*, "Meikle (1978) discussed [that] the funnelform perianth, the long-exserted stamens and style, the obscurely 10-ribbed, fusiform or clavate fruits with the large viscid glands, and the semiwoody nature of the plants all distinguish *Commicarpus* from *Boerhavia*" (Spellenberg 2003: 33).

Commicarpus scandens (Linnaeus) Standley
[*Boerhavia scandens* Linnaeus]
Climbing wart-club. Figure 12.

Figure 12. *Commicarpus scandens*. (A) Daniels Arroyo, W channel, 5 Sep 2014. (B & D) Ajo Mountain Drive, W slope of Ajo Mts, 27 Sep 2006. (C) Ajo Scenic Loop, Little Ajo Mts, 31 Jul 2014. (E) Diablo Mts, N part of Ajo Mountain Drive, 14 Sep 2013.

Perennial herbs or shrubs, often woody at base, reaching 1.5–1.8 m tall growing through other shrubs; glabrate. Stems slender, straight, and brittle, the internodes usually long. Leaves often

3–7.5 cm long, the petioles prominent, the blades nearly triangular to ovate and semi-succulent. Flowers in umbellate clusters; perianth 7–8 mm wide, white or whitish with a pale yellow-green center; flowering in the warmer seasons, especially with summer rains. Fruits club-shaped, 8–10 mm long, 10-ribbed, terete or nearly so, with viscid, knobby glands causing the fruit to stick to fur, feathers, and clothing. Fruits producing relatively small amounts of mucilage when wet.

Organ Pipe including the Ajo Mountains and along the southwestern margin of the Monument, and the east side of Cabeza Prieta; mostly washes, arroyos, and canyons.

Eastward and northward in southern Arizona to Texas, Mexico including both Baja California states, to South America and the West Indies.

OP: Estes Canyon Wash, 20 Aug 1950, *Supernaugh 446*. Quitobaquito, *Nabhan 17 May 1982*. Aguajita Wash, 14 Sep 1988, *Felger 88-401*. 1 mi W of Lukeville at international boundary fence, 18 Nov 1991, *Felger 91-136*. Senita Basin, 1 Dec 2001, *Beale & Beale 203*. Diablo Mts, 2405 ft, flowers visited by wasps, 12 Sep 2013, *Rutman 20120112-17*.

CP: E margin of Cabeza Prieta, 23 Feb 2003, *Rutman*, observation. Chico Sunie Wash near Chico Sunie Village, 5 Aug 2014, *Rutman*, observation. Daniels Arroyo, 5 Sep 2014, *Rutman*, photo.

Mirabilis – Four-o'clock; *maravilla*

Herbaceous perennials; the stems often forking. Leaves entire, the lower ones usually petioled, the upper ones reduced. Involucral bracts united, calyx-like, 5-lobed; 1–many flowers per involucre; involucres often clustered at stem tips. Flowers collapsing with daytime heat. Calyx petal-like, longer than the involucre. Stigmas capitate. Fruits rounded to elongated, smooth to slightly angled or ridged.

Americas, mostly temperate and tropical regions, and at least one in south Asia; 60 species. This is the most diverse genus in the family.

1. Flowers dark pink to red-purple, often 5–6 cm long..... **Mirabilis multiflora**
1. Flowers white, pale pink, or bright red-purple, not more than 2 cm long.

2. Leaves linear to linear-lanceolate, subsessile or petioles not prominent; flowers bright red-purple; Ajo Mts..... **Mirabilis coccinea**
2. Leaves deltate to ovate, the petioles prominent; flowers white to pale pink.

3. Involucres 6–9 mm long, the lobes 2–3 (4) mm long..... **Mirabilis laevis**
3. Involucres 10–15 mm long, the lobes 5–9 mm long..... **Mirabilis tenuiloba**

Mirabilis coccinea (Torrey) Bentham & Hooker f.
Scarlet four-o'clock. Figure 13.

Herbaceous perennials, growing and flowering with warmer months with sufficient soil moisture. Stems slender, forked and openly branched, generally erect-growing. Leaves linear to linear-lanceolate, not more than 10 cm long, subsessile or the petioles not more than 3 mm long. Flowers 1–3 in a cluster, bright red-purple, probably 1–2 cm wide, withering in morning heat. Fruits about 5 mm long. The plants are inconspicuous when the flowers are not open.

Known from a single collection in the Ajo Mountains.

Southeastern California, southern Nevada, New Mexico, northern Sonora, and northern Chihuahua (S of Gallego, *Shreve 9045-A*, ARIZ).

OP: Base of bedrock cliff, near crestline of Ajo Mts, 1155 m, few plants under a *Juniperus* at base of cliff in deep shade, 22 Oct 2006, *Rutman 20061022-7*.

Figure 13. *Mirabilis coccinea*. Alto Gulch, Salero Ranch, Santa Cruz Co., 4 May 2014, photos by Sue Carnahan.

†**Mirabilis coccinea** and/or **M. linearis** (Pursh) Heimerl
[*Oxybaphus linearis* (Pursh) B.L. Robinson]
Narrow-leaf four o'clock

Herbaceous perennials growing and flowering during the warmer months.

One or both of these species occur in the fossil record from the Ajo Mountains. *Mirabilis linearis* is presently widespread in Arizona to the north and east of the Sonoran Desert; the nearest populations are in the Pajarito and Santa Rita mountains. Three varieties range from Canada to Mexico; var. *decipiens* (Pursh) Heimerl ranges from Utah to Arizona, New Mexico, Chihuahua, and northeastern Sonora.

OP: †Montezuma's Head, anthocarps, 13,500 & 20,490 ybp.

Mirabilis laevis (Bentham) Curran var. **villosa** (Kellogg) Spellenberg
[*M. bigelovii* A. Gray]
Desert four o'clock. Figure 14.

Stems erect to spreading, slender, often dying back to rootstock during drought. Leaves semi-succulent, tardily drought deciduous, larger ones 2–4+ cm long including petioles, the blades deltate to ovate. Involucres green, enlarging moderately as fruits develop, reaching 6–9 mm long, the lobes 2–3 (4) mm long. Perianth white to pale pink; anthers yellow, the filaments and style white. Fruits seed-like, 3.8–4.4 × 2.5–3 mm, ovoid, faintly reticulate to mottled dark brown and gray, sometimes faintly glaucous. Flowering various seasons except during cold weather. Flowers often visited by honeybees.

Widespread in the region but often not conspicuous; rocky slopes and canyons, as well as washes or arroyos including valley floors and bajadas. Extending to the summits of mountains at least in Cabeza Prieta and Tinajas Altas. It has been part of the local flora for more than 29,000 years.

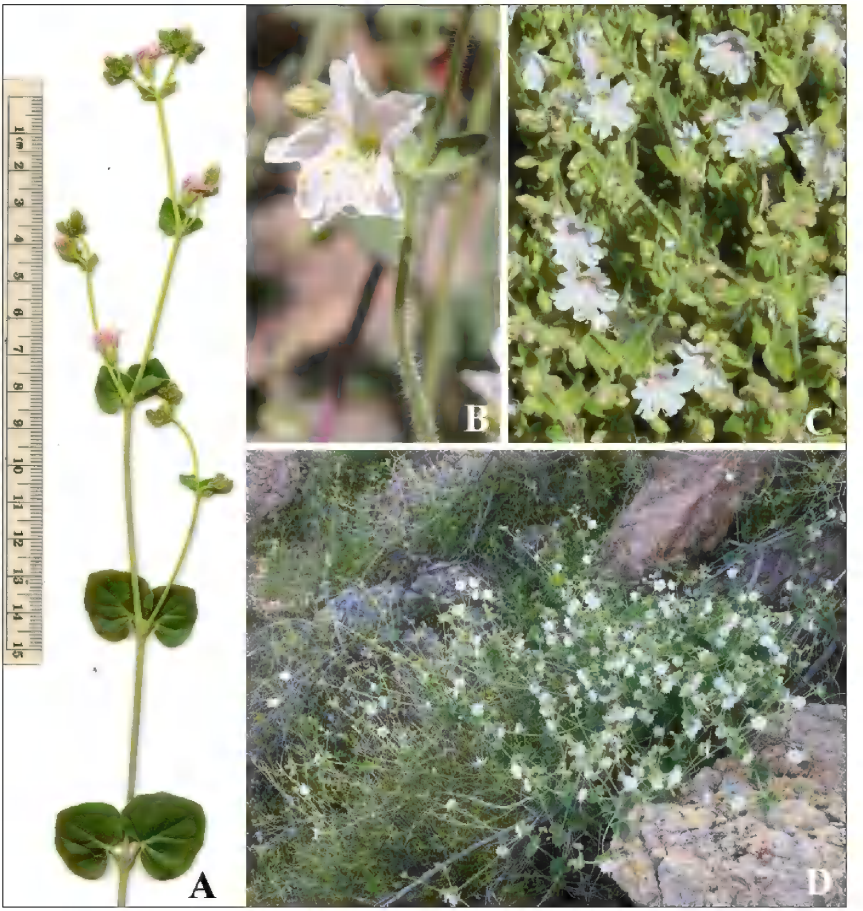

Figure 14. *Mirabilis laevis* var. *villosa*. (A) North slopes of the Puerto Blanco Mts, 15 Mar 2015. (B & D) Estes Canyon, 15 Mar 2008. (C) Alamo Canyon, 1 Feb 2014.

Variety *villosa* occurs in Arizona, northwestern Sonora, Baja California, and southern California to Nevada, and southwestern Utah. Three other varieties range from Baja California Sur to Oregon, Nevada, southwestern Utah, and northwestern Arizona.

OP: Ajo Mts, 21 Nov 1934, *Goodding 1515*. Alamo Canyon, 14 Mar 1941, *Benson 10678*. Dripping Springs, 18 Mar 1945, *Gould 3013*. Aguajita, wash, 6 Apr 1988, *Felger 88-286*. †Alamo Canyon, anthocarps, 8590 & 29,110 ybp. †Montezuma's Head, anthocarps, 20,490 ybp. †Puerto Blanco Mts, anthocarps, 7560 to 14,120 ybp (3 samples).

CP: Tule Tank, 26 Mar 1932, *Shreve 5931*. Eagle Tank, *Simmons 24 Feb 1964* (CAB). 6 mi E of Papago Wells, 28 Feb 1976, *McLaughlin 1031, Fugate & McManus* (ARIZ, SNM). Agua Dulce Pass, *Vetault*

29 Feb 1988. Cabeza Prieta Peak, 2550 ft, N side of summit, 24 Mar 1995, *Yeatts 3659.* W of Bluebird Mine, E Growler Mts, 22 Mar 2003, *Rutman 2003-378.*

TA: Tinajas Altas, 5 Dec 1935, *Goodding 1517.* Borrego Canyon, 16 Jun 1992, *Felger 92-614.* Coyote Water, 18 Mar 1998, *Felger 98-119.* Camino del Diablo, SE of Raven Butte, bajada, 25 Oct 2004, *Felger* (observation). †Butler Mts, anthocarp, 11,060 ybp.

Mirabilis multiflora (Torrey) A. Gray var. **multiflora**
Colorado four o'clock. Figure 15.

Herbaceous perennials with sprawling stems from tuberous roots; winter dormant, new shoots appearing in April. Leaves petioled; blades 5–10 cm long, mostly ovate, often asymmetric. Floral involucres often 2–3 cm long. Flowers usually 6 per involucre, the perianth often 3–5 cm long, bright dark pink to red-purple, closing in the early morning; flowering in summer. Fruits 6–10 mm long, dark brown to blackish, ovoid to rounded.

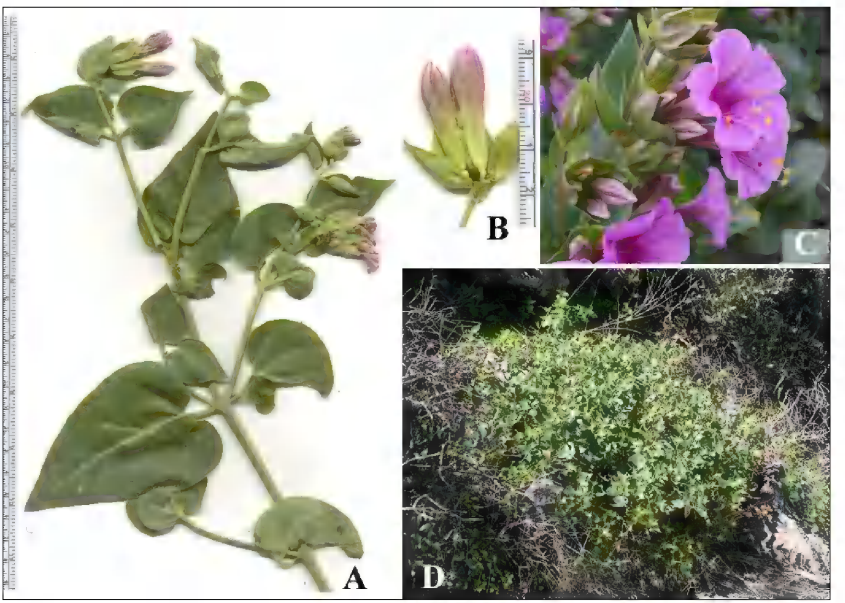

Figure 15. *Mirabilis multiflora.* (A & B) Arch Canyon, 21 Sep 2008. (C) Camp Creek, Tonto National Forest, 22 Apr 2010, photo by Elizabeth Makings. (D) Near saddle between Arch and Boulder canyons, 16 Sep 2006.

In the flora area known only from the Ajo Mountains; canyons and higher elevations in shaded microsites on rocky slopes often among oaks (*Quercus*) and rosewoods (*Vauquelinia*).

Mirabilis multiflora occurs in Arizona, generally above the desert, to Colorado, western Texas, Utah, California, Baja California, and northern Sonora to San Luis Potosí. Variety *multiflora* is the most widespread of the three varieties (Spellenberg 2003; Welsh et al. 1993).

OP: Boulder Canyon, rocky slopes, 2600 ft, 3 May 1978, *Bowers 1279.* Abundant on shaded, very steep N-facing slope below cliff, E of saddle between Arch and Boulder canyons, 26 Oct 2003, *Rutman 2003-1026-43.*

Mirabilis tenuiloba S. Watson
Long-lobed four o'clock. Figure 16.

Herbaceous perennials, sometimes flowering in the first year, often dying back to rootstock during drought; roots stout, somewhat thickened. Plants densely glandular-pubescent, especially the new growth and inflorescences. Leaves tardily drought deciduous, often 3–6+ cm long including petioles, the blades thick and semi-succulent, mostly deltate. Involucres green, enlarging moderately to 10–15 mm long as the fruits develop, the lobes 5–9 mm long. Perianth white. Fruits 4.4–5.4 × 3–3.6 mm, oval, brown, nearly smooth when fresh, to moderately reticulated or with low ridges when dry. Reproductive at various seasons except during colder weather. The plants are generally larger, more robust, and with larger, thicker, and more yellowish leaves and larger fruits than those of *M. laevis*.

Figure 16. *Mirabilis tenuiloba*. Palm Canyon, Kofa Mts, Yuma Co., 8 Oct 1977, *Harrison 11* (ASU 100323, from SEINet).

In Arizona known only from the Kofa Mountains and the flora area in the Tinajas Altas Mountains, including Borrego, Frontera, and Surveyors canyons where it is common on rocky slopes and canyon bottoms, often growing intermixed with *M. laevis* (Felger 1993). Canyons in the larger granitic mountains in the western part of Cabeza Prieta should be searched for this species.

In the USA known otherwise in the western part of the Colorado Desert in southern California. In Sonora known only from the Sierra del Rosario (Felger 2000); also the Baja California Peninsula and islands in the Gulf of California.

TA: Tinajas Altas Mountain, *Goodding 7 Mar1940.* Borrego Canyon, 16 Jun 1992, *Felger 92-613.* Frontera Canyon, 18 Mar 1998, *Felger 98-108.* Surveyors Canyon, 29 Mar 2010, *Felger 10-200.*

OLEACEAE – Olive Family

Trees, shrubs, or perennial herbs. Leaves opposite and decussate (alternate above in *Menodora*), simple or pinnately compound; stipules none. Flowers radial, bisexual or unisexual. Calyx 4 (–15)-parted or sometimes none. Corollas sympetalous, 4–6 lobed, or none. Stamens usually 2 or 4. Fruits highly variable, the seeds 1 (2–4) per chamber.

Mostly trees and shrubs, also vines and some herbaceous perennials. Worldwide; 24 genera, 615 species.

1. Trees; leaves pinnately compound..... **Fraxinus**
1. Perennial herbs or shrubs; leaves simple.

2. Woody shrubs with rigid branches; leaves and twigs smooth or with small but not rough hairs (not scabrous); flowers inconspicuous; fruits fleshy..... **Forestiera**
2. Perennial herbs to subshrubs with slender, brittle stems; leaves scabrous like sandpaper; flowers bright yellow; fruits dry (capsules)..... **Menodora**

Forestiera

Hardwood shrubs; Americas with 20 species.

Forestiera phillyreoides (Bentham) Torrey
[*F. shrevei* Standley. It seems a shame to lose this double pun named for the famous desert ecologist Forrest Shreve.]
Desert olive. Figure 17.

Multiple-stemmed hardwood shrubs 1.5–4 m tall. Branches rigid, opposite and decussate, with short spur-branches. Leaves winter- and drought-deciduous, mostly 1.5–2.8 cm long, oblong-elliptic to narrowly oblanceolate, glandular punctate, at first densely pubescent with soft, spreading hairs, becoming glabrate or glabrous with age; margins entire. Flowers small, yellow, 3–5 in axillary clusters, male and female flowers on separate plants, or perhaps some flowers bisexual, perianth absent or with a greatly reduced calyx; male flowers with 4 stamens, the anthers dark purple. Flowering in January and February before or with first leaves. Fruits of drupes, 7–10 mm long, fleshy, glaucous purplish-black, ellipsoid, moderately curved, 1-seeded; ripening in May.

Ajo Mountains and locally in the Puerto Blanco Mountains, mostly at higher elevations and in canyon bottoms above 750 m, often with oaks, and on rocky, especially north-facing slopes. It was in Alamo Canyon 1200 years ago.

Southern Arizona and northern and western Sonora, characteristically at the upper elevation range of the Sonoran Desert to lower oak woodland and chaparral-like vegetation. Also in north-central Mexico.

Fresh, ripe fruits of *Forestiera* are edible but were not widely used (e.g., Castetter & Opler 1936).

OP: Alamo Canyon: Above Alamo Ranch, 19 Apr 1933, *Shreve 6201* (isotype of F. shrevei); Large shrub 10–15 ft high, common in rocky soil on dry canyon floor with turbinella oak, mesquite, desert broom, 2500 ft, 17 Apr 1952, *Parker 7996.* Boulder Canyon, 2800 ft, canyon bottom, to 8 ft, 3 May 1978, *Bowers 1295.* Arch Canyon, shrub to 3 m tall, 12 May 1988, *Baker 7609* (ASU). Middle fork Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-329.* Large wash draining NE slopes of Pinkley Peak, 1800 ft,

locally common, 31 Oct 2003, *Rutman 20031031-5.* †Alamo Canyon, seeds, 1150 ybp (the specimen probably represents this species because it was in a modern assemblage of Sonoran Desert/chaparral species).

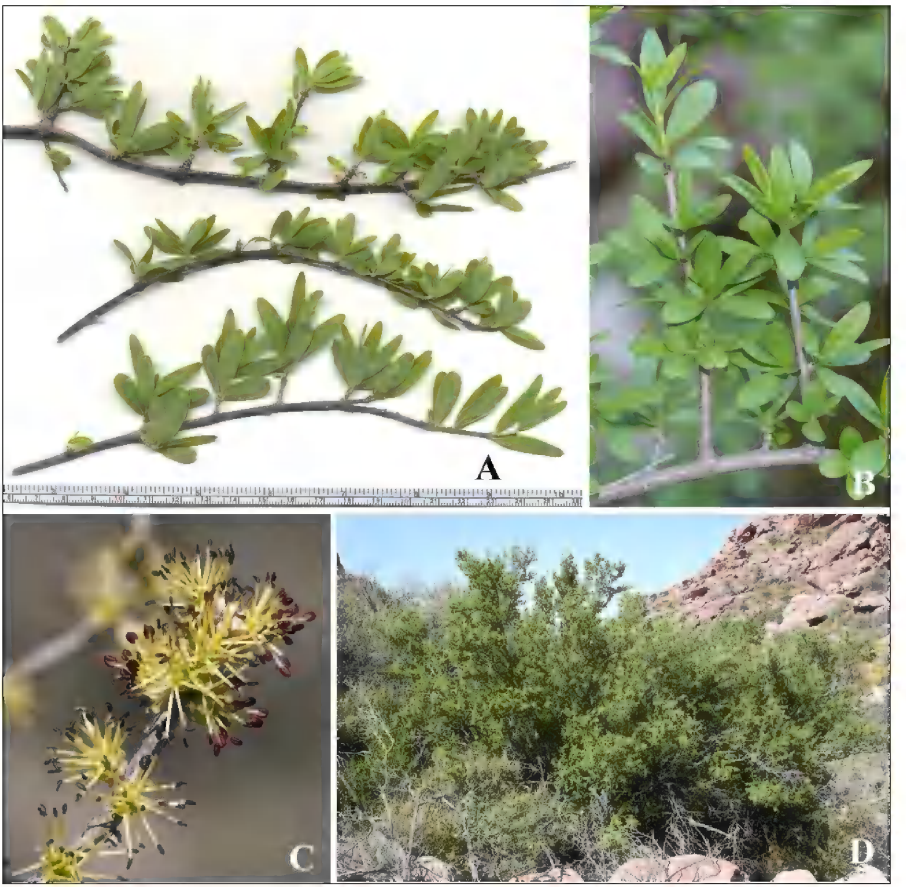

Figure 17. *Forestiera phillyreoides.* Alamo Canyon: (A) 21 Mar 2008; (B) 12 Mar 2005. (C) Staminate flowers, Tillotson Wash, S of confluence with Alamo Wash, 26 Jan 2009. (D) Wash NE of Pinkley Peak, Puerto Blanco Mts, 24 Mar 2008.

†**Forestiera** cf. **pubescens** Nuttall
[F. *neomexicana* A. Gray]

Winter-deciduous shrubs. The Alamo Canyon samples, from a pinyon-juniper-oak woodland midden assemblage, are likely to be *F. pubescens* rather than the present-day desert-edge species. The nearest present-day populations of *F. pubescens* are in Yavapai County in north-central Arizona. It ranges from California to Colorado and Texas, and northern Mexico.

OP: †Alamo Canyon, seeds, 32,000 ybp.

Fraxinus – Ash; *fresno*

Trees and some shrubs. Northern Hemisphere; 50 species.

****Fraxinus velutina** Torrey

Velvet ash; *fresno*

Winter-deciduous trees, the leaves becoming golden yellow in fall. Bark gray, with age deeply furrowed into forking ridges. Herbage velvety hairy, the leaves often glabrate with age. Leaves odd-pinnate, the leaflets (3) 5–9 per leaf. Male and female flowers mostly on separate trees; petals none. Flowers small, wind-pollinated. Fruits in pendulous clusters of samaras. Flowering probably in spring and perhaps sporadically through the summer.

Known from the flora area by a single specimen and not relocated in the field. It was often planted in the region as a shade tree at ranches and may have been planted in the canyon, or perhaps it was native and has since perished. The nearest naturally occurring population is in the Baboquivari Mountains.

Southwestern USA and northern Mexico.

OP: Alamo Canyon, 3000 ft, 14 Mar 1940, *Benson 10686*.

Menodora

Herbaceous perennials and shrubs. Two-dozen species in three disjunct regions; southwest North America (USA and Mexico), temperate South America (mainly Argentina), and southern Africa (Chumley 2007; Nesom in press; Turner 1991).

Menodora is monophyletic and forms a clade nested within *Jasminum* (Chumley 2007; Lee et al. 2007; Rohwer 1995, 1997; Wallander & Albert 2000). Chumley stated that the means of dispersal in *Menodora* is not known. However, we found that *M. scabra* seeds are sticky when fresh, and older, dry seeds become mucilaginous when wet and adherent upon drying (Walter Fertig, pers. comm. to Felger, Dec 2015), which may have a bearing on explaining the widely disjunct distributions among the species in this genus. In response to Felger's inquiry about *Menodora* seeds being mucilaginous, Prof. Jen Rohwer replied, "I am not surprised to hear that *M. scabra* has a myxotesta. This further underscores the close relationship with *Jasminum*. . . . *Jasminum* has a sarcotesta, i.e., a fleshy seed coat with greatly enlarged epidermal and/or subepidermal cells. Such a juicy tissue may also be sticky, and I guess that's the same in *Menodora*. It would certainly be worthwhile to study the development of the seeds in detail" (pers. comm. Dec. 2015).

Menodora scabra A. Gray

[*M. scoparia* Engelmann ex A. Gray]

Twinberry. Figure 18.

Subshrubs or perennial herbs, often 30–50 cm tall, the stems mostly erect, slender, leafy, and dying back in drought. Herbage and calyces with short, rough sandpaper-like hairs (scabrous puberulent). Leaves gradually drought deciduous, opposite below, alternate and reduced above; mostly 1.2–4.5 cm × 2–5 mm, sessile or subsessile, narrowly to broadly elliptic, narrowly oblong, or obovate, the tip acute; margins entire. Flowers solitary or inflorescences corymbose or paniculate; flowering during warm weather except in drought. Calyx deeply divided into 7–10+ linear lobes. Corollas bright yellow, 1.2–1.5 cm wide, 5- or 6-lobed. Stamens 2. Fruits of capsules with 2 inflated, membranous-papery hemispheres opening around the middle. Seeds 4 per chamber (8 total), 4–6 mm long, somewhat flattened; seed coat reticulate and pitted, with a spongy outer seed coat and a smooth hard, inner seed coat; fresh seeds very sticky, the dry seeds becoming mucilaginous when wet and adhering to a substrate upon drying.

Mostly north-facing slopes and canyons in ranges on the east side of Cabeza Prieta and widespread in Organ Pipe including the Ajo Mountains to the crestline.

Deserts and semi-arid regions in southwestern USA and northern Mexico.

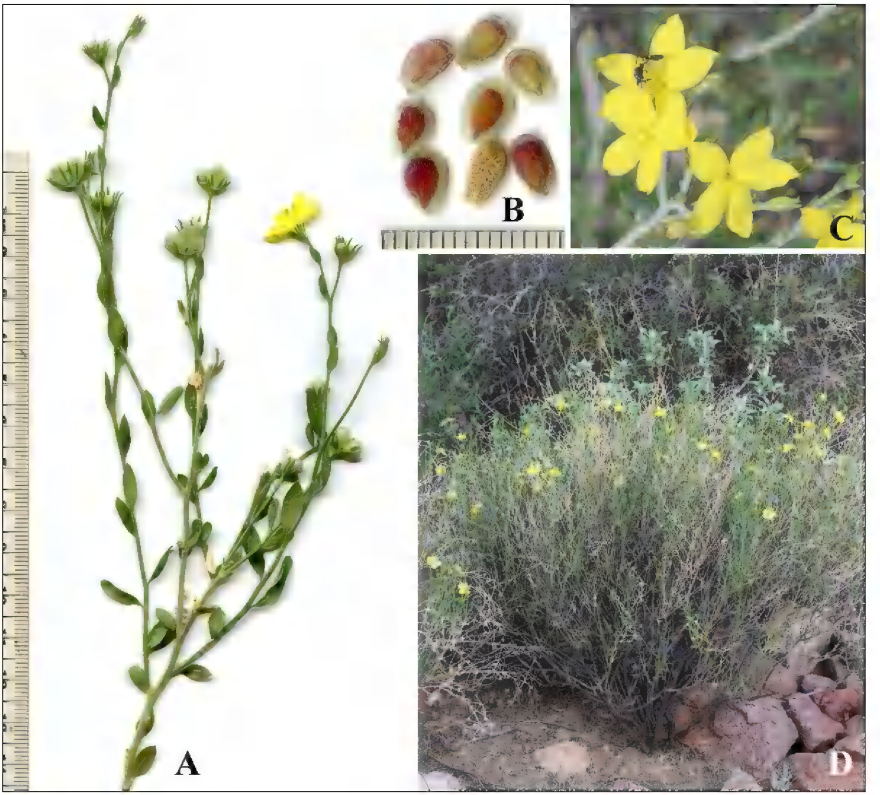

Figure 18. *Menodora scabra*. (A) Wash crossing Hwy 85 at mile 66.5, 2 Aug 2014. (B) Estes Canyon, 19 Sep 2014. (C) Sauceda Mts, 4 Aug 2013. (D) Between Arch and Estes canyons, Ajo Mountain Drive, 2 Aug 2013.

Nesom (in press) and Turner (1991) include *M. scoparia* as a synonym of a broadly interpreted *M. scabra*. Chumley (2007) treats them as separate species, restricting the range of *M. scoparia* mainly to regions east of the Continental Divide. In his dissertation, Chumley proposes four varieties of *M. scabra,* one of which, *M. scabra* var. *glabrescens* A. Gray, occurs in the flora area, and another one (not validly published) that occurs near the flora area. However, the distinction of var. *glabrescens* is rather weak (description incomplete) and we choose to recognize a broadly interpreted *M. scabra*. Evidently, more research is needed to understand the relationships among these plants.

OP: Senita Pass, 13 Apr 1941, *McDougall 85.* 1.5 mi SE of Bates Well, 18 Mar 1945, *Darrow 2429.* Dripping Springs, *Hesselberg 10 Apr 1966.* Ajo Mt Drive, 11 Nov 1988, *Beal & Beal 194.*

CP: Sheep Peak, N side, mid-elevations to peak, 31 Jan 1992, *Felger* (observation). Tuseral Tank, 5 Apr 1993, *Harlan 392*. Childs Mt, 9 Apr 1993, *Felger 93-289*.

†**Menodora** sp.

The fossil specimens may be *M. scabra*, or possibly *M. spinescens* A. Gray, a more northern species that may have occurred with Ice Age woodland vegetation.

OP: Montezuma's Head, seeds, 13,500 to 21,840 ybp (3 samples).

ONAGRACEAE – Evening-Primrose Family

Ephemerals or perennial herbs (those in the flora area; includes shrubs to trees elsewhere). Leaves alternate, opposite, or in basal whorls. Flowers usually with a floral tube (hypanthium), often more or less elongated, above the ovary, the tube producing nectar near its base; floral parts above the ovary usually deciduous after flowering. Sepals and petals each 4, separate above the hypanthium (summit of floral tube; the terms *sepal* and *petal* refer to the lobes or free portions of the calyx and corolla). Ovary inferior. Pollen grains usually among cobwebby threads. Style 1, stigma 2- or 4-lobed or discoid, capitate or elongated. Fruit a capsule or nut-like. In spite of the common name, this family is not related to the primrose family.

Worldwide, especially diverse in western North America; 22 genera, 660 species.

1. Perennials; flowers bright red; seeds with a tuft of hairs at one end..... **Epilobium**
1. Annuals/ephemerals or perennials; flowers variously colored but not bright red; seeds not hairy.

2. Petals (2) 2.5–6 cm long, uniformly (monochromatic) yellow or white without spots or other markings..... **Oenothera**
2. Petals 0.2–1.7 cm long, color various, often with spots or other markings.

3. Non-seasonal ephemerals/annuals; flowers diurnal; stigma 4-lobed; fruits indehiscent, nut-like and hard, 8–10 mm long, widest above middle, 1- or 2-seeded. .....**Oenothera curtiflora**
3. Ephemerals or short-lived perennials, growing and flowering during cool seasons; flowers opening near dawn or dusk and withering in mid-morning or mid-day heat; stigma hemispherical or capitate; fruits dehiscent capsules, (12) 15 mm long or more, widest at base or about same thickness throughout, many-seeded..... **Camissonia** sensu lato:

4. Flowers and capsules pedicelled..... **Chylismia**
4. Flowers and capsules sessile.

5. Flowers minute, petals 2–2.5 mm long, white or pink..... **Eremothera chamaenerioides**
5. Flowers small but not minute, petals 5–7.5 mm long, yellow or white.

6. Stems thick, the epidermis shiny whitish and peeling; inflorescences usually densely flowered, the flowers crowded, the petals white, the hypanthium 4.5–7 mm long; capsules woody, 12–20 mm long, 2–3 mm wide at base, abruptly tapering..... **Eremothera boothii**
6. Stems slender, the epidermis green, not peeling; inflorescences few-flowered, the flowers not crowded, the petals bright yellow, the hypanthium 0.7–0.9 mm long; capsules not woody, (32) 40–85 mm long, 1–1.4 mm wide throughout..... **Eulobus**

Camissonia sensu lato – Sun cup

Ephemerals or perennial herbs growing during cool seasons, segregated into several genera including *Chylismia*, *Eremothera*, and *Eulobus*. Leaves basal and/or along the stems, alternate, and

usually reduced upwards. Flowers 4-merous, opening near dawn or near sunset, withering with mid-morning or midday heat (remaining open longer on cooler days). Floral tube prolonged beyond the ovary, deciduous after flowering. Stigma almost always green. Stamens 8. Capsules straight or contorted, dehiscent, with many small seeds.

The smaller-flowered species, such as *Eremothera chamaenerioides,* are selfing (autogamous). The long, slender, nectar-filled floral tube (hypanthium) and evening-opening (vespertine) flowers of *Chylismia arenaria* suggest it is pollinated primarily by hawk moths, as in other evening primroses (e.g., certain *Oenothera*) with similar flower structure and biology. Other vespertine species, both white- and yellow-flowered, are undoubted visited by smaller moths. The outcrossing (allogamous) species open an hour or more before sunset and/or after sunrise, at which time they are pollinated by solitary, ground-dwelling bees. These bees tend to nest in sandy soils, and the lowland distribution of certain *Camissonia* may be largely controlled by the habitat needs of their pollinators. The female bees gather pollen to stock the larval cells in their underground nests.

Chylismia

Ephemerals to short-lived, herbaceous perennials, growing and reproductive during the cooler months. Abaxial (lower) leaf surfaces or margins with conspicuous (brown) oil cells. A genus segregated from *Camissonia*.

Western North America; 16 species.

1. Ephemerals or perennials; larger leaves on stems well above base of plant and not in a basal rosette; leaf blades about as wide as long, rounded to ovate or somewhat triangular, toothed or serrated. ..... **Chylismia arenaria**
1. Ephemerals; larger leaves in a basal rosette, stem leaves reduced; leaf blades more than 3 times longer than wide, the leaves pinnately lobed to divided..... **Chylismia claviformis**

Chylismia arenaria A. Nelson
[*Camissonia arenaria* (A. Nelson) P.H. Raven. *Oenothera arenaria* (A. Nelson) P.H. Raven]
Fortuna suncup. Figure 19.

Ephemerals, often robust, to short-lived subshrub perennials. Plants 15–60 cm tall, with soft, spreading, long white hairs. Stems leafy. Petioles (2.5) 3.5–6 cm long; leaf blades 2–5.5 cm long, orbicular to deltate, the bases cordate, the margins toothed. Flowers vespertine, 6.5–8 cm long including the pedicel; hypanthium often 25–35 mm long; petals often 10–16.5 mm long, bright yellow, drying pinkish. Capsules (2) 3–4.6 cm long, straight or nearly so; fruiting pedicels 2–20 mm long.

Rocky slopes and canyons in mountains at Tinajas Altas and the western part of Cabeza Prieta, often in rock crevices.

Western Arizona, southeastern California, and northwestern Sonora.

CP: Tule Tank, *Hinckley 26 Mar 1932.* 3.8 mi W of Tule Tank, *Van Devender 9 Mar 1980.*
TA: Tinajas Altas, 5 Mar 1927, *Harrison 3608.* Canyon above Tinajas Altas, 28 Oct 2004, *Felger 04-83.*

Figure 19. *Chylismia arenaria*. (A) Tinajas Altas, Yuma Co., 2 Mar 2014, photo by Sue Carnahan. (B) Chiraco Summit, Riverside Co., California, 9 May 2012, photo © by Keir Morse.

Chylismia claviformis (Torrey & Frémont) A. Heller
[*Camissonia claviformis* (Torrey & Frémont) P.H. Raven. *Oenothera claviformis* Torrey & Frémont]
Browneyes

Spring ephemerals. Stems branching mostly from the base, (10) 15–45+ cm long. Leaves in a basal rosette, reduced above; rosette and lower leaves (3.5) 6–30 cm long, the blades more or less elliptic, pinnately dissected, variously lobed or toothed, the lower segments of larger leaves often of separate lateral leaflets, the smaller and/or upper leaves often entire; basal leaves often withering by time of flowering and fruiting. Veins on lower leaf surfaces conspicuously brown due to crowded oil cells. Inflorescences ascending, nodding at tips. Flowers vespertine, pedicelled, attractive, often (12) 15–18 mm wide, the petals white or yellow, becoming pink with age and often purplish when dry, the stamens and style of the same color as petals; center (hypanthium) orange-brown. Fruiting pedicels and capsules spreading to erect-ascending; fruiting pedicels 4–20 mm long, the capsules 13.5–27 mm long, moderately club-shaped (slightly enlarged at apex), often 1.8–2 mm wide near apex, straight or slightly curved. (This description pertains to the species as it occurs in the flora area.)

Western USA, Baja California and Sonora. Two of the 12 subspecies occur in the flora area. Bean and Saubel (1972) report that the plants were eaten as greens.

1. Plants glandular hairy, especially the leaves and inflorescence; petals (corolla lobes) white, changing to pink, often drying purplish; sepals with caudate tips arising from the apex (tip). ..... **Chylismia claviformis** subsp. **peeblesii**
1. Plants glandular hairy or not; petals bright yellow, remaining yellow or becoming reddish with age; sepals with caudate tips arising below the apex..... **Chylismia claviformis** subsp. **rubescens**

Chylismia claviformis subsp. **peeblesii** (Munz) W.L. Wagner & Hoch
[*Camissonia claviformis* subsp. *peeblesii* (Munz) P.H. Raven]
Browneyes. Figure 20D–F.

Corollas white, sometimes pink-tinged, and with a red-brown center, the flowers becoming pink with age and often purplish when dry, the stamens, style, and stigma white.

Often on sandy to gravelly soils including dunes of the Pinta Sands; widespread across the flora area.

Arizona, northwestern Sonora, and New Mexico.

OP: Alamo Canyon, *Nichol 26 Mar 1939.* 0.5 mi N of Pozo Nuevo, 30 Mar 1978, *Bowers 1104.*
CP: Jacks Well, *Furlow 14 Mar 1979.* Cholla Pass, 11 Apr 1992, *Harlan 179* (CAB). Papago Well, 10 Apr 1993, *Felger 93-380.*
TA: Tinajas Altas, *Van Devender 5 Mar 1983.*

Chylismia claviformis subsp. **rubescens** (P.H. Raven) W.L. Wagner & Hoch
[*Camissonia claviformis* subsp. *rubescens* (P.H. Raven) P.H. Raven]
Browneyes. Figure 20A–C.
Corollas yellow, with age becoming red-orange, the throat maroon.

Common on sandy soils and dunes; especially in the western part of Cabeza Prieta and the western part of Organ Pipe.

Figure 20. *Chylismia claviformis* subsp. *rubescens*: (A & B) Puerto Peñasco, Sonora, 19 Feb 2015. (C) Growler Valley along Bates Well Road, 29 Feb 2008. Subsp. *peeblesii*: (D) Valley of the Ajo, W of Hwy 85, 5 Feb 2005. (E) Wash crossing Hwy 85 between Ajo and Gila Bend, 28 Feb 2015. (F) Sierra del Águila near Hwy 2, Sonora, 7 Mar 2015.

Southwestern Arizona and northwestern Sonora.

OP: ¼ mi by road N of junction of Bates Well Road and road to Cabeza Prieta Refuge, 30 Mar 1978, *Bowers 1138.* Flat N of Pozo Nuevo Hills, *Casper 14 Mar 2003* (ORPI).

CP: Pinacate Lava Fields, 20 Mar 1933, *Shreve 6211.* O'Neill Hills, 15 Apr 1941, *Benson 10774.* W side of S end of Sierra Pinta, *Monson 20 Mar 1958.* Pinta Sands, 1 Feb 1992, *Felger 92-34.*

Epilobium

Annual and perennial herbs and subshrubs; worldwide; 200 species.

Epilobium canum (Greene) P.H. Raven subsp. **latifolium** (Hooker) P.H. Raven
[*Zauschneria californica* Presl subsp. *latifolia* (Hooker) D.D. Keck]
California fuchsia, hummingbird trumpet. Figure 21.

Perennials with erect to decumbent stems and shredding bark. Leaves opposite, subsessile, 1–5 cm long, linear to ovate, toothed or entire. Flowers bright scarlet and bilateral, the hypanthium 2–3 cm long, tubular and moderately flared above, the petals 8–15 mm long; flowering at various seasons. Capsules 2–3.5 cm long, sessile or short-pedicelled. Seeds with deciduous white tufts of hairs.

Ajo Mountains, in moist or wet soils in canyon bottoms.

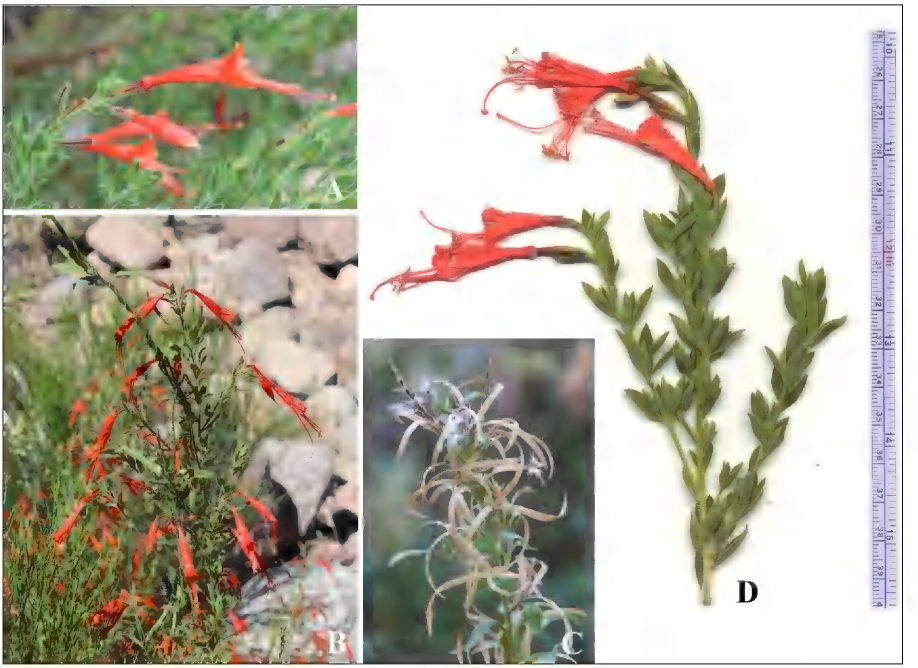

Figure 21. *Epilobium canum* subsp. *latifolium.* Alamo Canyon: (A & D) 7 Sep 2013; (B) 17 Oct 2013; (C) 12 Jan 2014.

Oregon and Wyoming to New Mexico, Baja California, northern and eastern Sonora, and Chihuahua. Five other subspecies occur within the same range.

OP: Alamo Canyon, *Nichol 14 Mar 1939.* Bull Pasture, *Henry 1978* (ORPI). S fork of Alamo Canyon, 7 Sep 2013, *Rutman 20130907-3.*

Eremothera

Ephemerals growing and reproductive during the cooler months. Leaf blades often red spotted or reddish. Flowers small and whitish. Capsules sessile. Western North America; 7 species. A genus segregated from *Camissonia*.

1. Stems relatively thick, the epidermis shiny whitish and peeling; petals 5–7.5 mm long; capsules thickest at the base and woody..... **Eremothera boothii**
1. Stems slender, epidermis green, not peeling; petals 2–2.5 mm long; capsules uniformly slender and not woody. ..... **Eremothera chamaenerioides**

Eremothera boothii (Douglas) W.L. Wagner & Hoch subsp. **condensata** (Munz) W.L. Wagner & Hoch
[*Camissonia boothii* (Douglas) P.H. Raven subsp. *condensata* (Munz) P.H. Raven]
Woody bottle-washer. Figure 22.

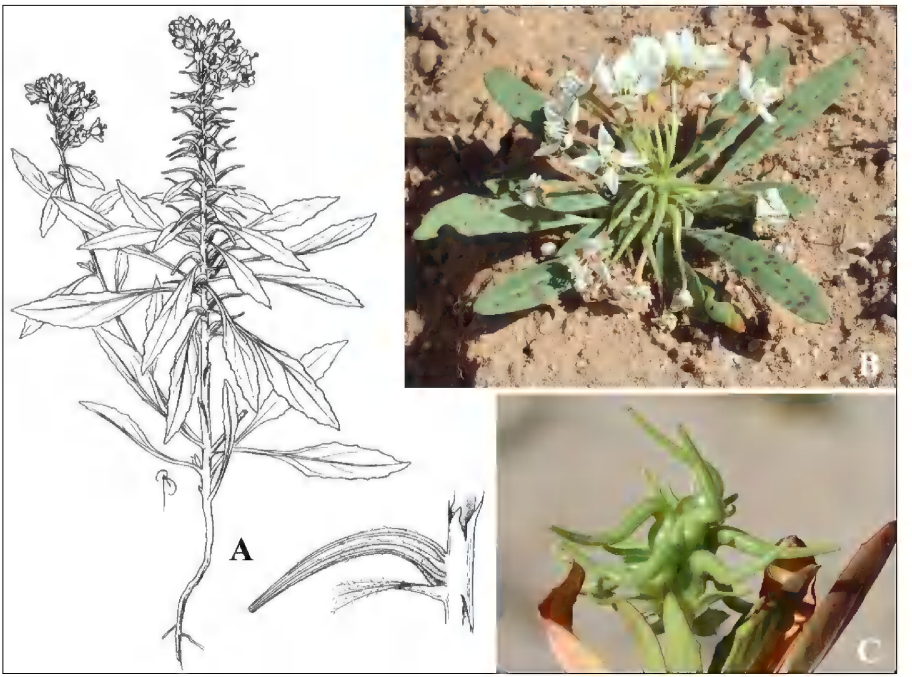

Figure 22. *Eremothera boothii* subsp. *condensata*. (A) By Bobbi Angell. (B) San Cristobal Valley, 13 Mar 2014. (C) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 15 Feb 2014.

Plants mostly (6) 8–23 cm tall. Stems relatively thick, the epidermis shiny silvery-white and peeling. Young herbage, lower leaf surfaces, and inflorescences sparsely to densely hairy with small glandular as well as larger non-glandular white hairs, becoming glabrate or glabrous with age. Leaves larger and petioled below, 3–14 cm long, becoming smaller and nearly sessile upwards; leaf blades mostly narrowly oblanceolate to narrowly elliptic, the margins minutely toothed or sometimes entire. Inflorescences densely flowered, buds on larger plants nodding. Flowers 16–29 mm long,

presumably vespertine, noticeably fragrant; hypanthium 4.5–7 mm long; sepals becoming pinkish with age; petals 5.6–7.5 × 3–4.2 mm, white, and narrowed at base. Capsules 12–20 mm long, abruptly tapering, 2–3 mm wide at the base, rigid and woody, obscurely 4-angled, bent downward and often twisted, and tardily dehiscent. Skeletons of stems and woody capsules persistent.

Scattered and generally not common, sandy soils of washes and desert plains; Cabeza Prieta especially in the western portion, and in the western part of Organ Pipe.

This subspecies occurs in southern and western Arizona, southern Utah, southern Nevada, southeastern California, northeastern Baja California, and northwestern Sonora; five other subspecies in western USA.

OP: NW corner of Monument, 21 Mar 1941, *McDougall 7.* 0.5 mi N of Pozo Nuevo, 30 Mar 1978, *Bowers 1097.*

CP: Between Bates Well and Papago Well, *Hinkley 25 Mar 1932* [or perhaps in Organ Pipe]. NE edge of Las Playas, 15 Apr 1964, *Niles 356.*

Eremothera chamaenerioides (A. Gray) W.L. Wagner & Hoch
[*Camissonia chamaenerioides* (A. Gray) P.H. Raven]
Willow-herb evening–primrose. Figure 23.

Plants (5) 12–50 cm tall, with glandular hairs and small coarse non-glandular hairs near the inflorescences. Herbage often reddish; stems very slender. Leaves 15–70+ × 1–15 mm, green or reddish with dark red spots, the blades more or less elliptic, entire to sparsely and shallowly toothed or crenulate. Flowers opening near sunset. Sepals reflexed, cream-white inside, pink outside. Petals often 2–2.5 mm long, whitish, often with a broad pink midstripe or markings, or becoming pink with age. Filaments white. Stigma at first white, becoming yellowish to pinkish by morning, surrounded by the anthers at anthesis, both at the same height, the anthers often touching the stigma. Capsules 2.8–6 cm × 0.7–1 mm, sessile, terete, and straight. This is the smallest-flowered evening primrose in the Sonoran Desert; the floral structure and modifications are characteristic of self-pollinated flowers.

Widespread across the flora area in many habitats, mostly at lower elevations.

Southeastern California to western Utah and western Texas, both Baja California states, and northwestern Sonora.

OP: Alamo Canyon, *Nichol 14 Mar 1939.* Quitobaquito Hills, 18 Mar 1945, *Darrow 2412.* 0.5 mi N of Pozo Nuevo, 30 Mar 1978, *Bowers 1106.*

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3950* (CAB). San Cristobal Wash, 11 Apr 1992, *Harlan 162b.* Bassarisc Tank, 26 Feb 1993, *Felger 93-121.*

TA: Tinajas Altas, *Goodding 6 Mar 1940* (ASU). Tinajas Altas, rocky slope, 1900 ft, *Van Devender 5 Mar 1983.* Above the tinajas, 19 Mar 1998, *Felger* (observation). Surveyors Canyon, canyon bottom, 29 Mar 2010, *Felger 10-211.*

Figure 23. *Eremothera chamaenerioides*. (A) Ten Mile Wash at Ajo Picnic Area, 26 Feb 2015. (B & E) Alamo Canyon, 26 Feb 2015. (C) Hat Mountain, Sauceda Mts, 22 Mar 2013. (D) Sandy Wash near Hwy 85 near N end of Organ Pipe, 25 Feb 2015.

Eulobus

Annuals to subshrubs; southwestern USA and northwestern Mexico; 4 species. A genus segregated from *Camissonia*.

Eulobus californicus Nuttall ex Torrey & A. Gray
[*Camissonia californica* (Nuttall ex Torrey & A. Gray) P.H. Raven]
California suncup. Figure 24.

Spring ephemerals, 15–70+ cm tall, with an erect main axis and ascending straight branches, solitary, sparsely branched, or sometimes much branched. First leaves in a basal rosette or often not forming a basal rosette. Young herbage, buds, and immature fruits glabrate or sparsely pubescent with short white hairs as well as small glandular hairs, becoming glabrous with age. Larger (lower) leaves often 3–24 × 0.4–3.7 cm, petioled, the blades linear to narrowly elliptic, the margins pinnately

and coarsely lobed and/or toothed; stem leaves reduced above. Plants leafy when young, becoming leafless or nearly so with warmer, drier weather at flowering time. Flowers opening near dawn (observed to be closed until at least 10 p.m. and open at 5 a.m.) and withering in mid-morning or mid-day heat. Flowers often 15–18 mm wide; petals 5–7 mm long, bright yellow, sometimes with red flecks, changing to orange, drying pink. Style, stigma, anthers, and filaments bright yellow. As the flower matures the anthers collapse on top of the stigma. Ovary slender, 15–30 mm long; capsules (3.2) 4–8 cm × 1–1.4 mm, straight to slightly curved, and turning downward.

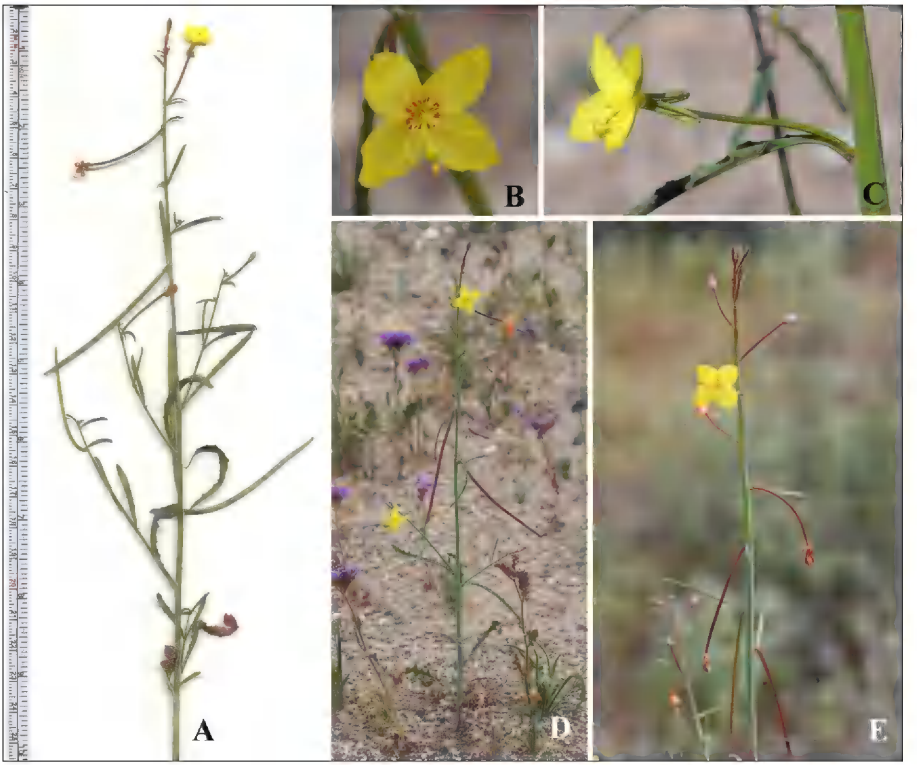

Figure 24. *Eulobus californicus*. (A) Kuakatch Wash, 21 Mar 2008. (B & D) Valley of the Ajo, 8 Mar 2008. (C) Alamo Canyon, 26 Feb 2014. (E) Estes Canyon, 18 Mar 2005.

Widespread and common across the flora area; washes, plains, bajadas, rocky slopes, canyons, and stabilized dunes.

Western Arizona, southern California, Baja California, Baja California Sur, and northwestern Sonora.

Eulobus californica is "mostly self-pollinating, and apparently always self-compatible" and "rarely visited by insects" (Raven 1969: 198). The four species of *Eulobus* share some striking similarities, such as general size and the leafless condition at flowering time.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939.* Alamo Canyon, *Nichol 14 Mar 1939.* 9 mi S of N of entrance on Sonoyta Road, 8 Apr 1941, *McDougall 45.* Quitobaquito, 6 Apr 1988, *Felger 88-312.*

CP: N Pinta Tank, *Simmons 7 Mar 1964.* Bassarisc Tank, Cabeza Prieta, *Furlow 14 March 1979.* Old ranch site 4.7 mi NE of Tule Well, 28 Mar 1985, *McLaughlin 2975.* Charlie Bell Pass, 3 Apr 1992, *Whipple 3914.* Pinta Sands, dunes, 11 Apr 1993, *Felger 93-417.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.* Tinajas Altas Canyon, above the tinajas, 19 Mar 1998, *Felger* (observation). Vicinity of Coyote Water, 25 Oct 2004, *Felger 04-34.* Surveyors Canyon, canyon bottom, 29 Mar 2010, *Felger 10-206.*

Oenothera – Evening-primrose

Winter-spring ephemerals (except *O. curtiflora*), with a well-developed taproot (those in the flora area, elsewhere includes small to large perennial herbs). Leaves in a basal rosette or alternate, with large, attractive, nocturnal (vespertine) flowers pollinated by hawk moths, fading within a day, and many-seeded woody capsules. Sepals 4, reflexed in anthesis. Petals 4. Stamens 8. Stigma of 4 linear lobes. *Oenothera curtiflora* differs in being non-seasonal and with small pink, diurnal flowers, and a nut-like fruit. Americas; 145 species.

1. Flowers diurnal; petals pink and less than 0.5 cm long; fruits indehiscent, nut-like and hard, 8–10 mm long, widest above middle, 1- or 2-seeded..... **Oenothera curtiflora**
1. Flowers nocturnal or variously remaining open on cool days, petals yellow or white and (2) 2.5–6 cm long.

2. Petals yellow; capsules (1.8) 2.8–4.6 cm long, 6.4–7.5 mm wide at base, erect, straight, and tapering to a conspicuously narrowed tip; ovary and fruits with papillate-based hairs, the papillae relatively large and usually reddish..... **Oenothera primiveris**
2. Petals white when fresh, becoming pink with age; capsules 4–6.5+ cm long, 2–3.5 mm wide at base, often curved and usually moderately bent downward, tapering only slightly; fruits hairy but not papillate-based.

3. Buds (sepals) purple-spotted; petals 2.5–3.6 cm long..... **Oenothera arizonica**
3. Buds (sepals) not purple-spotted, of one color; petals 2–5 (6) cm long..... **Oenothera deltoides**

Oenothera arizonica (Munz) W.L. Wagner

[*O. deltoides* Torrey & Frémont var. *arizonica* Munz. *O. californica* S. Watson subsp. *arizonica* (Munz) W. Klein. *O. avita* (W. Klein) W. Klein subsp. *arizonica* (Munz) W. Klein]

Arizona evening-primrose. Figure 25.

Cool-season ephemerals with basal rosettes and leafy stems; stems spreading to decumbent, larger stems often 30–60 cm long and 2.5–4 mm diameter, with whitish, smooth, peeling epidermis, the younger herbage and inflorescences often sparsely hairy. Leaves relatively slender and pinnatifid, somewhat regularly cleft to parted more than halfway to the midrib, the basal leaves often reaching 15–30 cm with very long, slender petioles, the stem leaves (3.5) 5.5–15+ × 0.5–3.8 cm. Leaves and bud sepals with both smaller and larger white hairs, the larger hairs 0.9–1.5 mm long, flat, and ribbon-like (pilose). Larger plants with flowers in upper stems. Buds with conspicuous purple spots usually surrounding the larger hairs. Petals 2.5–3.6 cm long, white, becoming pale pink with age. Capsules 5–7.5 cm × 2–2.3 mm at base, narrowly sub-cylindrical, nearly straight to moderately curved, spreading to downwardly bent, woody at maturity.

Locally common in sandy and deep loam soils of washes, flats, and dunes in the southern part of Cabeza Prieta, and the northwestern part of Organ Pipe and the adjacent eastern portion of Cabeza Prieta.

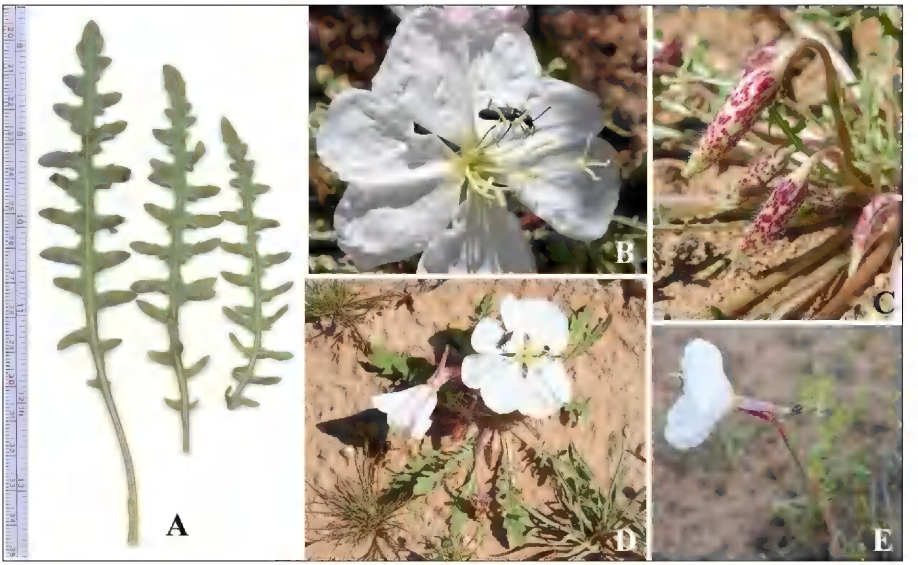

Figure 25. *Oenothera arizonica*. (A) Pinta Sands, 11 Feb 2014. (B–E) Near The Adobe, upper Daniels Valley, 26 Feb 2005.

Sandy soils in southern Arizona, Yuma to Cochise counties and western Sonora southward to Tastiota (28°20'N).

OP: Near Growler Pass, 22 Mar 1935, *Kearney 10856*. Wash near Sonoita Road, *McDougall 10 April 1941*. Cuerda de Leña wash, 31 Mar 1978, *Bowers 1156* (ORPI). W of Cuerda de Leña at N boundary of ORPI, *Rutman 6 Apr 1998* (ORPI). Growler Wash, 1.5 mi downstream from Bates Well, *Rutman 4 Mar 2001* (ORPI).

CP: 13 mi E of Tule Well, 30 Mar 1933, *Shreve 6222*. N of Las Playas, *Darrow 15 Apr 1941*. Pinta Sands, 1 Feb 1992, *Felger 92-36*. 0.2 mi W of San Cristobal Wash [at Camino del Diablo], 20 Mar 1992, *Harlan 15b*.

Oenothera curtiflora W.L. Wagner & Hoch
[*Gaura parviflora* Douglas ex Lehmann]
Lizard tail, velvet-leaf gaura. Figure 26.

Non-seasonal ephemerals, tall and slender, often reaching 1 (2) m tall, with a solitary axis or branched above the middle; herbage with glandular and long spreading non-glandular hairs. Leaves soft and velvety pubescent, elliptic to oblanceolate or obovate; first leaves, at least in winter-spring plants, in a basal rosette; stem leaves alternate 4–20 cm long and often deciduous by flowering time, narrowed to a winged petiole, the margins shallowly toothed to entire. Flowering during warmer months. Inflorescence a spike-like raceme, 19–33+ cm long, not leafy, erect, slender, densely and many-flowered. Flowers opening near sunset, withering within one day, bilateral, 4-merous; sepals 3.4–4.5 mm long, reflexed (at least in daytime); petals 2–3.6 mm long, clawed (narrowed) at base, and initially white, becoming bright pinkish-red; filaments, style, and stigma white to pink. Fruits 8.5–10 mm long, hard, indehiscent, nut-like, spindle-shaped, and widest above the middle; 1- or 2-seeded.

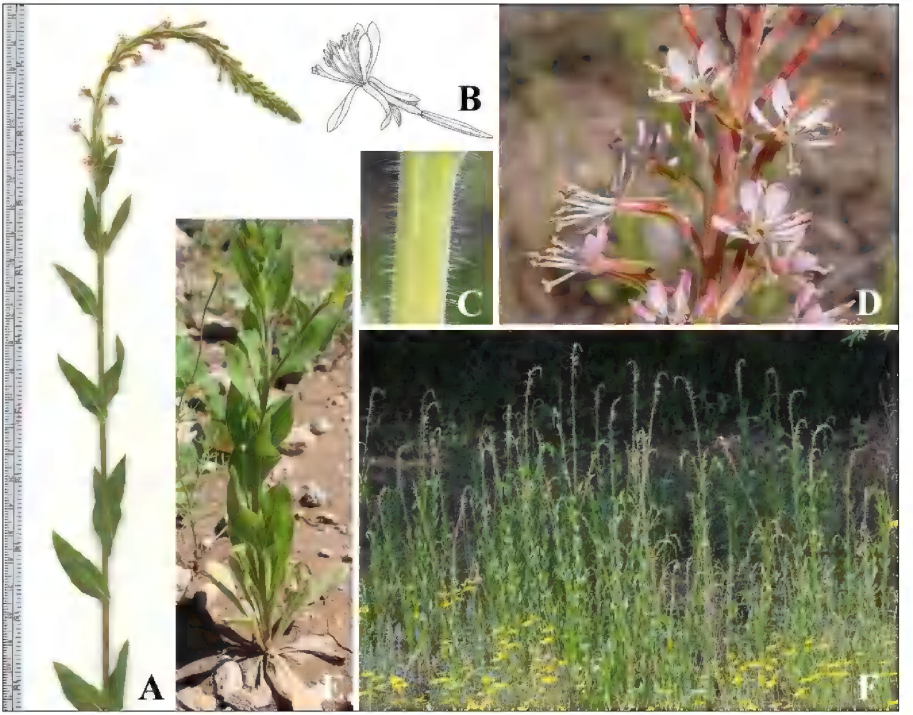

Figure 26. *Oenothera curtiflora*. Pinacate Junction, Pinacate Biosphere Reserve, Sonora: (A) 28 Mar 2013; (C) 5 Mar 2014; (E) 7 Mar 2015; (F) 8 Mar 2013. (B) By Lucretia Breazeale Hamilton. (D) Bond Canyon Creek, Salero Ranch, Santa Cruz Co., 21 May 2014, photo by Sue Carnahan.

In Organ Pipe at Quitobaquito and Cabeza Prieta on sandy to silty, or clayish soils of playas, charcos, arroyo beds, and waterholes.

Across much of the USA and northern Mexico, and adventive in many parts of the world. It was "probably originally native to the shortgrass prairie in the interior of the USA, and spread widely from there as a weed of cultivated and waste areas. Owing to its strict autogamy, it easily becomes established from a single fruit" (Raven & Gregory 1972: 26).

OP: Quitobaquito, 10 Apr 1986, *Felger 86-174A.*
CP: 11 mi W of Bates Well, 14 Apr 1941, *Benson 10748.* Las Playas, *Monson 25 Apr 1958* (CAB). Jose Juan Tank, 26 Feb 1993, *Felger 93-105.*

Oenothera deltoides Torrey & Frémont subsp. **deltoides**
Dune evening-primrose, white desert-primrose, devil's lantern. Figure 27.

Small to large plants, with a basal rosette and usually developing leafy stems. Stems of well-watered plants to 50+ cm long, stout, semi-succulent, and with silvery whitish, peeling epidermis. Young herbage and sepals (buds) densely pubescent with white hairs. Leaves 3.5–22 cm long, the blades lanceolate or elliptic to ovate (narrower in drought-stunted plants), often coarsely toothed or

lobed, sometimes nearly entire, or the lower segments sometimes distinct and the leaves lyrate-pinnatifid; petioles often longer than the blades. Leaves often reduced upward, but the stem leaves of large, robust plants scarcely or not at all reduced. Corollas white, often pale pink with age, with a pale yellow-green "eye" around the mouth of the tube, the petals 2–5.5 (6) cm long, broadly obovate, the tip notched. Capsules rigid and woody at maturity, nearly straight to curved, spreading to usually moderately bent downward, 4–6.5 cm long, 2–3.5 mm wide at the base, narrowly cylindrical (tapering slightly). The dry, dead plants form basket-like skeletons that may persist for several years, hence the name devil's lantern (Figure 27D).

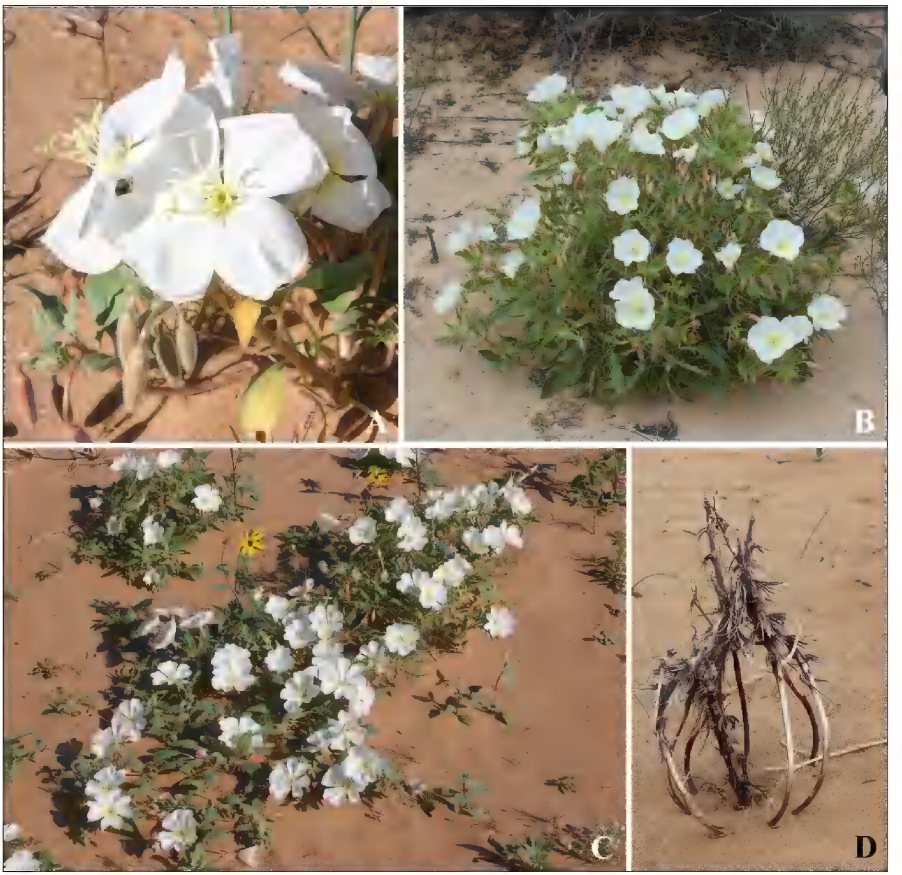

Figure 27. *Oenothera deltoides* subsp. *deltoides*. (A) Puerto Peñasco, Sonora, 16 Feb 2008. (B) Dunes near the Maya Palace, E of Puerto Peñasco, Sonora, 20 Feb 2015. (C) Dunes about 37 km SW of Sonoyta on Mex Hwy 8, Sonora, 27 Mar 2010. (D) Gran Desierto near Mex Hwy 2, 6 Feb 2014.

Especially common in the western part of Cabeza Prieta on sandy soils including dunes, also washes, sand hummocks, and roadsides. It is often abundant on dunes and sand flats during cooler seasons of wet years.

Western Arizona, southern Nevada, southeastern California, Baja California, and northwestern Sonora. Subspecies *deltoides* is the southernmost of the several subspecies that range northward to Oregon and Utah.

The large white flowers open shortly before dusk and remain open until about an hour after sunrise to late-morning, or nearly all day in cool weather. As with *O. primiveris*, when the flowers first open the stigmas and anthers are held away from each other, effectively preventing self-pollination. By morning the flowers on some plants still have the stigma and their lobes held well above the anthers, on other plants the style hangs down so that the stigma is away from the anthers, and on still others the stigma lobes arch down and touch the anthers.

This is one of the most conspicuous spring wildflowers in the sandy desert of southwestern Arizona and northwestern Sonora. During favorable years it can form a major portion of the biomass of the dunes. Towards the end of the season the plants are often ravaged by hoards of sphinx moth caterpillars (*Hyles lineata*). These caterpillars can destroy almost the entire fruit (seed) crop (Felger 2000).

Lumholtz (1912: 331) reports that this species was cooked as greens (he called it *O. trichocalyx*).

CP: 13 mi E of Tule Well, 20 Mar 1933, *Shreve 6222*. Pinta Sands, 1 Feb 1992, *Felger 92-35*. Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-353*. Las Playas, 11 Jan 2002, *Felger 02-41*.

Oenothera primiveris A. Gray
Yellow evening-primrose. Figure 28.

Winter-spring ephemerals; often developing a thick taproot. Leaves in basal rosettes, nearly stemless or developing a stout, erect, leafy stem sometimes 10–20 cm long. Pubescence of bristly, spreading, bulbous-based white hairs. Leaves (3.3) 5–27 cm long, the larger ones 3.5–7 cm wide, mostly pinnatifid into toothed or rounded lobes, narrowed into a long, winged petiole expanded at the very base. Flowers opening at dusk, closing the following morning. Petals and stigma bright lemon yellow, the petals (1.8) 3.5–5.5 cm long, notched at the tip (flower, leaf, and plant size correlated with soil moisture). Ovaries and fruits densely hairy with large, spreading white hairs, each from a large, conical, fleshy, translucent bulbous base (papilla or gland). Capsules (1.8) 2.8–4.6 cm long, 6.4-7.5 mm wide at base, thick and woody, upright, straight, 4-angled, tapering to a conspicuously narrowed tip. The dry skeletons, consisting of part of the taproot and stem and a cluster of woody capsules, may persist for several years.

Sandy-gravel or silty-clayish soils of washes, sand flats, lower dunes, and playas, also canyons and rocky slopes (to at least 3200 feet in the Ajo Mountains); widespread and common across the flora area.

Southern Arizona to western Texas, southwestern Utah to southeastern California, Baja California, and northern Sonora. Those in the flora area are generally identifiable as subsp. *bufonis* (M.E. Jones) Munz, distinguished by larger and generally cross-pollinated flowers, but smaller-flowered plants are also present.

OP: Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939*. 9 mi by road (2-way section of Puerto Blanco Drive) W of Hwy 85, 26 Feb 1978, *Bowers 1082* (ORPI). Rocky slopes NW of Kino Peak, 1782 ft, 20 Mar 2005, *Rutman 2005-0320-44* (ORPI).

CP: 13 mi E of Tule Well, 20 Mar 1933, *Shreve 6222*. Pinta Sands, 1 Feb 1992, *Felger 92-35*. Las Playas, 11 Jan 2002, *Felger 02-41*. Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-353*.

TA: Canyon below lowermost Tinajas Altas, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-54.*

Figure 28. *Oenothera primiveris.* (A) Hwy 85 near N boundary of Organ Pipe, 14 Feb 2015. (B) Kuakatch Wash near Hwy 85, 6 Feb 2005. (C & D) Hwy 85 mile 28, between Ajo and Gila Bend, 8 Mar 2015. (E) Sand flats S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 17 Feb 2008.

OROBANCHACEAE – Broomrape Family

Ephemerals and herbaceous perennials, with chlorophyll or root parasites lacking chlorophyll; often glandular. Leaves alternate, the stems leafy or leaves reduced to scales; stipules none. Flowers bilateral, calyx 4- or 5-lobed; corollas 5-lobed and 2-lipped. Stamens 4, sometimes with a rudimentary fifth stamen. Ovary superior. Fruit a capsule; seeds numerous and minute. Worldwide; 99 genera, 2060 species.

1. Stems not succulent; plants with chlorophyll; calyx 4-lobed..... **Castilleja**

1. Stems succulent; root parasites without chlorophyll; calyx 5-lobed..... **Orobanche**
Castilleja – Paintbrush, owl's clover

Annual and perennial herbs; hemi-parasites on roots of grasses and herbaceous plants. Leaves alternate. Flowers sessile or essentially so, subtended by colorful bracts. Calyx 4-lobed, colored like the bracts. Upper lip of corolla forming a hood enclosing the anthers. Americas and northern Asia; 200 species.

1. Spring ephemerals, seldom more than 15 cm tall, with glandular hairs, not felt-like and not woolly; floral bracts lavender..... **Castilleja exserta**
1. Perennial herbs, often 30+ cm tall, with white, felt-like woolly hairs; floral bracts red-orange.
..... **Castilleja lanata**

Castilleja exserta (A. Heller) T.I Chuang & Heckard subsp. **exserta**
[*Orthocarpus purpurascens* Bentham]
Purple owl's-clover. Figure 29.

Attractive spring ephemerals, glandular puberulent and with long hairs. Leaves 1–5 cm long, pinnately cleft with linear to thread-like lobes. Flowers crowded in terminal spikes. Bracts, calyx, and petals showy, lavender, about 1–2+ cm long, the bracts multiple-lobed, the corollas with yellow and red spots terminally.

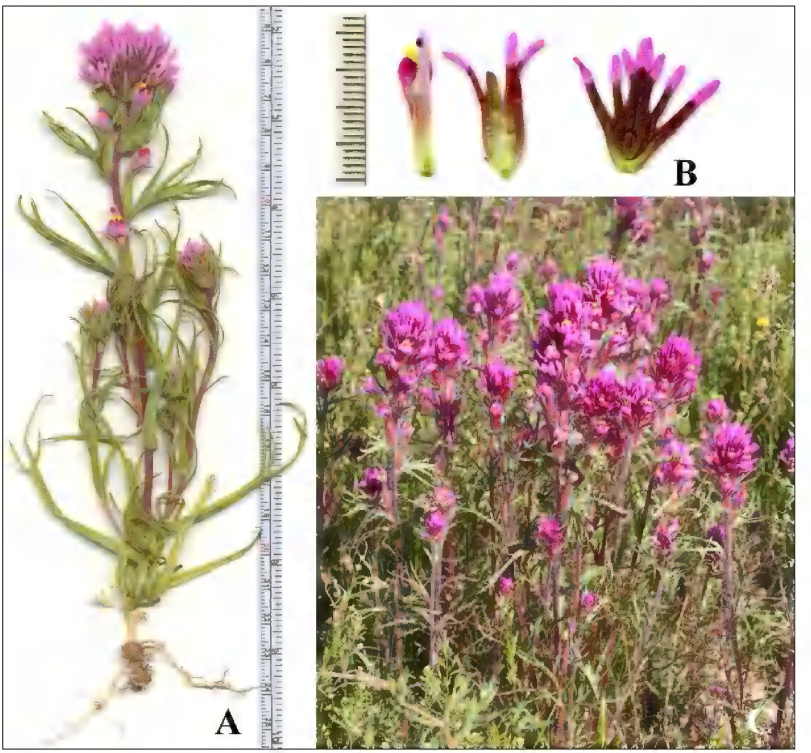

Figure 29. *Castilleja exserta* subsp. *exserta*. (A) Estes Canyon, 2 Mar 2008. (B) Left to right: corolla, calyx, and bract, Midway Wash near Hwy 85, 8 Mar 2015. (C) Near Hat Mountain, Sauceda Mts, 27 Feb 2005.

Bajadas and lower slopes in the eastern and central part of Organ Pipe; dense populations often localized; more common and widespread to the north and east of the Monument. Also a single record from the southeastern part of Cabeza Prieta.

This subspecies occurs in western and southern Arizona, southwestern New Mexico, California, Baja California, and northern Sonora. Two other subspecies occur in California.

OP: Alamo Canyon, 2500 ft, *Nichol 14 Mar 1939*. W base of Ajo Mts, 2500 ft, 14 Mar 1941, *Benson 10656*. Puerto Blanco Mts, beginning of trail to Dripping Springs, 4 Apr 1973, *Holmgren 6650* (ASU, DES). W flank of Bates Mts, 31 Mar 1978, *Bowers 1167* (ORPI). Below Dripping Springs, 30 Jan 1986, *Phillips 86-10* (MNA, ORPI).

CP: Jose Juan Charco, *Prosopis* and annual forbs, clay soil, *Cutler 17 Mar 1995* (CAB).

Castilleja lanata A. Gray
Indian paintbrush. Figure 30.

Perennial herbs, densely white to grayish woolly-pubescent. Stems often to 30+ cm tall. Longer leaves often 2–7 (8) cm long; leaves densely white to grayish woolly, mostly entire, linear or some with 3 slender lobes. Floral bracts deeply 3-cleft, the lobes broad, red-orange and showy, the corollas ca. 3.5 cm long, tubular and yellow.

Ajo and Diablo mountains in canyons, on rocky slopes, and sometimes shallow soils, at middle to upper elevations, and also higher elevations in the Puerto Blanco Mountains and occasional in the Growler Mountains.

Eastward in southern and central Arizona to west Texas, both Baja California states, and northern Sonora to Nuevo León, San Luis Potosi, and Zacatecas.

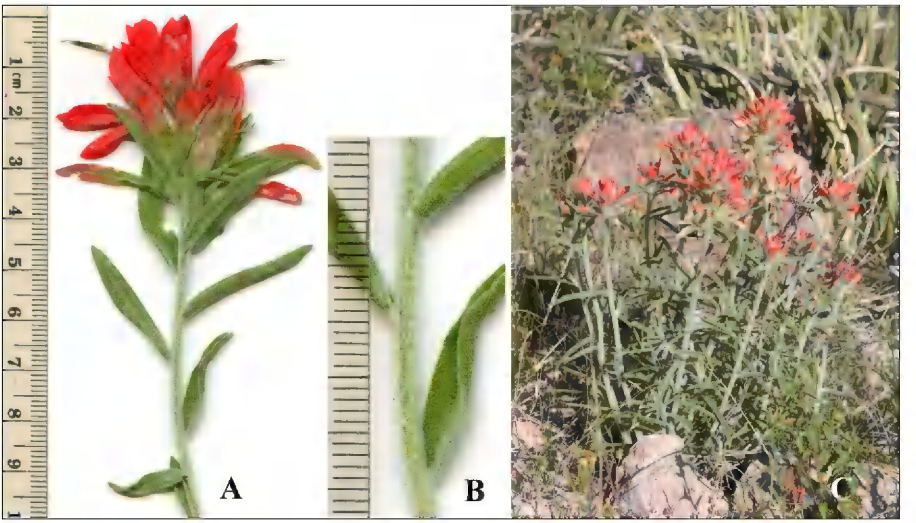

Figure 30. *Castilleja lanata*. (A) Trail to Bull Pasture, 8 Sept 2014. (B) Upper middle fork of Alamo Canyon, 15 Apr 2008.

OP: Alamo Canyon, *Nichol 4 May 1939*. Summit of Ajo Mts, 1 Apr 1944, *Clark 11526* (ORPI). Arch Canyon, *Fay 18 Feb 1978*. Boulder Canyon, 3 May 1978, *Bowers 1283*. NW of Pinkley Peak, *Rutman 24 Mar 2001* (ORPI). Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-23*.
CP: Growler Mts, canyon on E side near base of mountain, 24 Mar 2009, *Holm 20090324-4*.

†**Castilleja** sp./spp.

There is one Ice Age record for Tinajas Altas, although no member of the genus presently occurs there. The Organ Pipe fossils are from the Ajo Mountains where both present-day species occur.

OP: †Alamo Canyon, seeds, 8130 to 29,110 ybp (4 samples). Montezuma's Head, seeds, 20,490 ybp.
TA: ††Tinajas Altas, seeds, 11,040 ybp.

Orobanche – Broomrape

Ephemerals (those in the flora area; elsewhere annual to perennial herbs), root parasites without chlorophyll, growing with cooler seasons, the roots short, stubby and coral-like, and without root hairs. Stems succulent. Leaves reduced to scales, alternate but tending to form a series of tight spirals. Flowers bilateral; calyx 5-lobed; corollas tubular, 5-lobed and 2-lipped. Stamens 4, sometimes with a rudiment of a fifth stamen. Capsules with numerous minute seeds. Worldwide; 150 species.

1. Plants more than 10 cm tall; inflorescence stalks thick and multiple-flowered, the flowers purple and white..... **Orobanche cooperi**
1. Plants generally less than 10 cm tall; inflorescence stalks relatively slender, each with one or several flowers, the flowers yellow..... **Orobanche fasciculata**

Orobanche cooperi (A. Gray) A. Heller
[*O. ludoviciana* Nuttall var. *cooperi* (A. Gray) Beck]
Desert broomrape; *flor de tierra*; mo'otadk. Figure 31.

Stems very thick and succulent, the basal portion below ground, roots coral-like, the above-ground stem and inflorescence 10–37 cm tall, suffused with purple-brown, unbranched or with several branches usually from near the base. Plants, especially the flowers, glandular hairy. Shoots appearing in spring, flowering and withering by the end of April or earlier. Flowers 2–3 cm long, the lower ones pedicelled, the upper ones sessile. Corollas 5-lobed, purple and white, the throat marked with yellow. Stigmas peltate (shallowly cup-shaped) and often bilobed. Parasitic on roots of *Ambrosia* shrubs including *A. deltoidea*, *A. dumosa*, and probably sometimes *A. ilicifolia*. Wiggins' (1964) report of *Larrea* as a host plant seems unlikely (see Collins & Yatskievych 2015).

Often locally common on low hills, sandy flats, sandy-gravelly washes, and floodplains. Widespread across the flora region. *Orobanche cooperi* has been in the Puerto Blanco Mountains for at least 3500 years (Puerto Blanco Mts, capsules, 990 & 3440 ybp).

The young shoots, available in spring, were apparently widely used, often roasted in coals. The label on a specimen at the Gray Herbarium (Harvard University), collected by Carl Lumholtz in the Pinacate Region of northwestern Sonora, reads: "slightly bitter, Papago Indians toast and eat the plant at this stage. . . . called 'Camote' by Spaniards," indicating that non-Indians also knew of it being edible. The Cahuillas likewise ate them "before the plants blossom . . . roasted in the coals" (Barrows 1900: 66) and "peeled prior to eating" (Bean & Saubel 1972), and the Pimas prepared them in a similar manner (Moerman 2003). Richard and some friends roasted succulent but mature plants and found them very bitter: "Too bad we did not know to look for younger ones or to peel them." Caution: some people have adverse reactions to eating these plants (Amadeo Rea, pers. comm. to Felger 2003).

Figure 31. *Orobanche cooperi*. (A) Sikort Chuapo Mts near the Pipeline Road, 3 Mar 2009. (B) Five-lined sphinx moth (*Hyles lineata*) visiting flower, Kuakatch Wash near Hwy 85, 7 Mar 2009. (C) Kuakatch Wash near E boundary of Organ Pipe, 9 Feb 2014.

Collins and Yatskievych (2015) recognize three subspecies of *Orobanche cooperi*, one in the Chihuahuan Desert and two in the Sonoran Desert, both of which occur in the flora area.

1. Corollas (15) 18–22 mm long, lips 5–9 mm long, the lobes with or without an apiculate tooth; anthers glabrous or sparingly villous, stalked glands present or sometimes absent. ..... **Orobanche cooperi** subsp. **cooperi**
1. Corollas 22–32 mm, lips 6–10 mm, upper lobes with an apiculate tooth; anthers pubescent, with stalked glands on dorsal surface..... **Orobanche cooperi** subsp. **latiloba**

Orobanche cooperi subsp. **cooperi**

"The range of this subspecies is primarily in Arizona (south of the Mogollon Rim) and southern California and extends into the extreme northern part of Sonora and Baja California. It is sympatric with subsp. *latiloba* throughout almost its entire range" (Collins & Yatskievych 2015: 15). However, there are relatively few specimens from the flora area in southwest Arizona, and it is far more common in places farther north and east such as the Catalina Mountain region near Tucson, although there are a few Sonoran collections (George Yatskievych, pers. comm. to Felger, 14 Sep 2015).

The following specimens were determined as subsp. *cooperi* by L.T. Collins, A.E.L. Colwell, and G. Yatskievych, 2015:

OP: Aguajita Spring and vicinity, edge of wash, not common, 6 Apr 1988, *Felger 88-300.* **Pima Co.**: Gunsight, 3 mi E of Organ Pipe, 2000 feet, 14 Mar 1941, *Benson 10651.*

Orobanche cooperi subsp. **latiloba** (Munz) L.T. Collins
[*O. ludoviciana* Nuttall var. *latiloba* Munz. *O. multicaulis* Munz]

This subspecies is common across the flora area and elsewhere in southwest Arizona. It occurs in the Sonoran Desert in Arizona, California, Baja California, Baja California Sur, and Sonora. It differs from subsp. *cooperi* in part by having larger flowers.

The following specimens were determined as subsp. *latiloba* by L.T. Collins, A.E.L. Colwell, and G. Yatskievych, 2015:

OP: Bates Well, 28 Apr 1939, *Nichol 7791.* Sandy wash in *Cercidium–Hymenoclea* association, 1400 ft, 7 mi S of Bates Well, 17 Mar 1945, *Gould, Darrow & Haskell 2981.* Apparently on *Franseria ambrosioides*, deep sand, in wash, creosote bush, palo verde association, foothills of Growler Mts, 1300 ft, 16 Apr 1952, *Parker 7975.*

CP: Wash 10 mi S of Bates Well, Growler Mts, 1150 ft, 5 Mar 1940, *Benson 9922.* Silt valley, Camino del Diablo, 4 mi SE of Tuseral Tank road junction, *Franseria deltoides* (host), *Larrea*, *Simmons 3 Apr 1964.* Desert flats, 1 mi E of Papago Well on Camino del Diablo, 13 Mar 1983, *Eiber 22.* Sand dunes, E side of Pinacate lava flow–Camino del Diablo junction, 32º06'N, 113º27'W, 700 ft, 21 Mar 1992, *Harlan & Telewski 99.*

TA: W slope of Tinajas Altas Mts near junction of Camino del Diablo and Cipriano Pass Road. 870 ft, growing in *Ambrosia dumosa*, *Van Devender 6 Mar 1972.* In sand along the Camino del Diablo, near the tip of Vopoki Ridge, parasitic on the roots of *Franseria dumosa*, near Benchmark 809, *Halse 31 Mar 1973.* Sandy soil along wash with *Encelia farinosa*, 1 mi N, 4 mi W of Tinajas Altas Spring, Tinajas Altas Mts, *Lindquist & Van Devender 26 Mar 1983.*

The following specimens have not been determined to subspecies but are likely to be subsp. *latiloba*:

OP: Bates Well, Armenta Well, *Warren 6 May 1975.* 3.5 mi E of Dos Lomitas, 31 Mar 2003, *Rutman 2003-436* (ORPI).

CP: Heart Tank, *Monson 27 Mar 1955* (CAB). Lower slopes of Growler Mt, NE of Charlie Bell Pass, tributaries to Daniel's Arroyo, 20 Mar 1992, *Crawford 1 & Ayers* (ASC). Pinta Sands, *Mathes 21 Mar 1992* (ASC). 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002.*

TA: Frontera Canyon, 18 Mar 1998, *Felger 98-104.*

Orobanche fasciculata Nuttall
Yellow broomrape, clustered broomrape. Figure 32.

Plants to 15 cm tall. Stems and flowers with stalked glands. Stems several and slender, branched or solitary, each bearing one to several bright yellow flowers in spring. Flowers pedicellate, 1.5–3 cm long.

In the flora area known from the Ajo Mountains, in Alamo Canyon and perhaps also occasionally in the middle to upper elevations. Generally not occurring elsewhere within the Sonoran Desert.

Western and central North America from Alaska to northern Mexico.

OP: Ridge due S of Alamo Canyon primitive campground, Apr 1991, *Marian Rohman* (photo, ARIZ, ORPI). Alamo Canyon, middle fork, 2863 ft, shallow soil on a N-facing bedrock bed-slope above the middle fork, immediately adjacent plants *Bouteloua repens*, *Eriogonum fasciculatum*, 25 Apr 2003, *Rutman 2003-497* (ORPI).

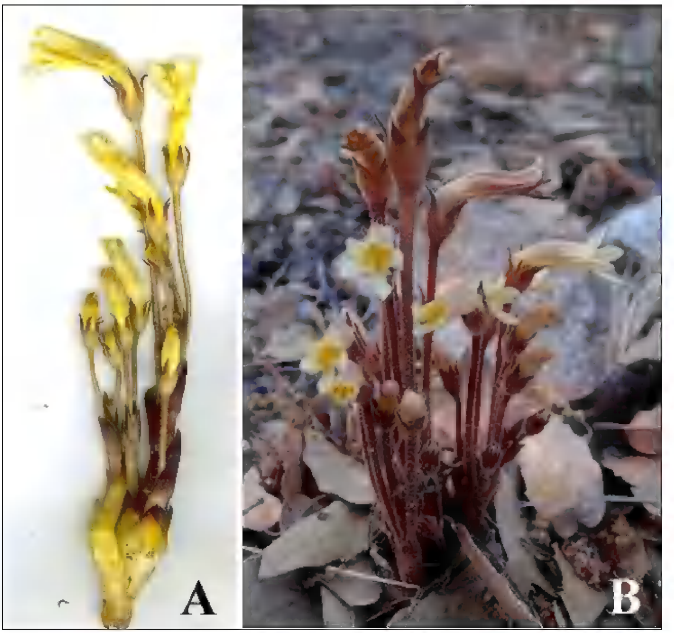

Figure 32. *Orobanche fasciculata*. (A) Upper middle fork of Alamo Canyon, 26 Mar 2005. (B) Miller Creek Trail, Rincon Mts, 15 Apr 2015, photo by Sue Carnahan.

OXALIDACEAE – Oxalis Family

Herbs and vines to trees. Worldwide; 6 genera, 770 species.

Oxalis – Wood-sorrel

Annual or perennial herbs, rarely succulent shrubs; worldwide; 700 species.

Oxalis albicans Kunth

Wood sorrel. Figure 33.

Semi-succulent, perennial herbs with a woody taproot, and slender, lax stems to 25+ cm long; plants with both large and small short hairs, many of them curled or crisped and 0.3–0.5 mm long. Leaves alternate, clover-like with 3 leaflets that fold along the midrib to close at night. Leaflets obcordate, to 1.5 cm long. Inflorescences slender, with 1–3 flowers. Flowers on slender pedicels, radial, with 5 sepals and 5 petals. Petals bright yellow, clawed, 1 cm long. Fruits cylindroid, fleshy and explosively dehiscing capsules. Reproductive spring to fall.

Canyon bottoms and moist, often shaded habitats at higher elevations in the Ajo Mountains.

Arizona to southwest Texas, and northern Mexico including Baja California Sur.

OP: N slope of canyon N of Alamo Canyon, 3500 ft, shaded slopes, 31 Mar 1948, *Darrow 3854*. Bull Pasture Trail, 11 Sep 1988, *Wilson 190*. Arch Canyon, beneath arch, *Rutman 26 Sep 2002* (ORPI). Bull Pasture, 9 Apr 2005, *Felger 05-174* (ARIZ, ASU).

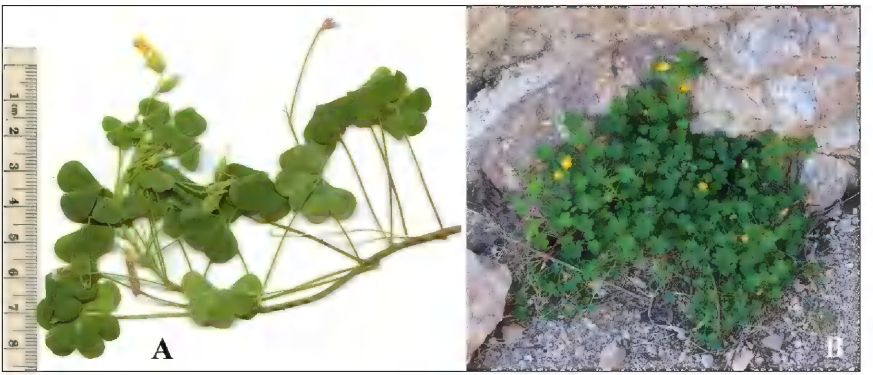

Figure 33. *Oxalis albicans*. Bull Pasture Trail: (A) 19 Sep 2014; (B) 7 Mar 2014.

PAPAVERACEAE – Poppy Family

Cool-season ephemerals and perennial herbs (those in the flora area; elsewhere sometimes also shrubs and small trees); with diverse alkaloids in milky (latex) colored or colorless sap. Leaves alternate; stipules none. Flowers radial. Sepals 2 or 3, enclosing the bud before it opens and falling as the flower opens. Petals separate, often twice as many as the sepals. Stamens many. Fruits of capsules. Seeds numerous.

Worldwide; 44 genera, 825 species.

1. Plants coarse and spiny throughout..... **Argemone**
1. Plants delicate and unarmed (spineless)..... **Eschscholzia**

Argemone – Prickly poppy, *cardo*

Thistle-like herbaceous perennials or facultative annuals, often robust (rarely shrubs); herbage, sepals, and fruits glaucous and conspicuously prickly-spiny throughout, with toxic yellow or orange latex when fresh, black when dry. First leaves usually in a basal rosette; leaves sessile, the upper ones clasping. Flowers large. Sepals mostly 3, each with sub-terminal spinescent horns. Petals usually 6. Stamens numerous. Capsule valves opening terminally; seeds numerous. Americas and Hawaii; 30 species.

1. Sap (latex) pale lemon-yellow; petals white, 3–5 cm long; stamens 150 or more; capsules 3–4.5 cm long..... **Argemone gracilenta**
1. Sap bright yellow; petals yellow, 2.5 cm long; stamens 40–75; capsules 2.5–3.5 cm long. ..... **Argemone ochroleuca**

Argemone gracilenta Greene

Prickly poppy, cowboy's fried eggs; *cardo*. Figure 34.

Robust herbaceous perennials often to 1+ m tall, also flowering in first season. Herbage, sepals, and fruits glaucous and densely prickly-spiny. Sap lemon-yellow, drying black. Leaves 8–20 (40) cm long, pinnately lobed, thistle-like. Flowers large, with white petals 3–5 cm long, and about 150+ yellow stamens. Often flowering during hot weather in late spring or early summer after most wildflowers have dried up, and continuing sporadically through the summer. Capsules 3–4.5 cm long.

Figure 34. *Argemone gracilenta*. (A–C) Why, 3 Apr 2005. (D) West of Three Points (Robles Junction), Hwy 86 at mile 145, 16 Apr 2015.

Widely scattered across the flora area at lower elevations and often seasonally abundant in low-lying, poorly drained silty-clayish soils of floodplains and playas, sandy washes, and often in disturbed habitats.

Arizona, western Sonora, and both Baja California states.

OP: Walls Well, *Nichol 28 Apr 1939.* West gate [Bates Well Road at N boundary of Monument], 1500 ft, 23 Apr 1942, *Cooper 611.* Loamy flat W of Cuerda de Leña wash, just S of N boundary, 23 Mar 2003, *Rutman 2003-390* (ORPI).

CP: Las Playas, 31 Jan 1992, *Felger 92-11.* Between O'Neill Hills & Pinacate Lava, 17 Mar 1992, *Yeatts 3208* (CAB). Daniels Arroyo at Charlie Bell Road, 9 Apr 1993, *Felger 93-365.*

****Argemone ochroleuca** Sweet subsp. **ochroleuca**
Mexican prickly poppy; *cardo.* Figure 35.

Herbage, sepals, and fruits glaucous and conspicuously prickly-spiny. Sap bright yellow. Leaves 8–15+ cm long, pinnately lobed, thistle-like. Petals pale yellow, 2.5 cm long. Stamens 40–75, pale yellow. Capsules 2.5–3.5 cm long.

Widely scattered, rarely encountered, and probably not established in the flora area; washes and disturbed habitats such as roadsides. In the mid-1990s it was locally common in Gunsight Wash but died out during two consecutive dry winters of the late 1990s. Probably not native in the flora area.

Figure 35. *Argemone ochroleuca* subsp. *ochroleuca*. (A) Near Alamos, Sonora, 9 Apr 2015; (B) Alamos, 30 Apr 2014; photos by Sue Carnahan. (C) Agua Dulce Wetland, Ironwood Forest National Monument, 16 Apr 2015, photo by Elizabeth Makings.

This species is weedy and adventive worldwide, the original distribution difficult to determine. The plants and flowers are smaller than those of the white-flowered prickly poppy.

OP: Growler Wash, 1 mi downstream from Bates Well, petals light yellow, *Johnson 25 Apr 1992* (ASU, det. G.B. Ownby 1992).

Eschscholzia – Gold poppy

Winter-spring ephemerals in the Sonoran Desert. Glabrous, the sap colorless. Leaves 3-times dissected into linear segments. Flowers yellow to orange, open during the day, closing in cloudy weather. Sepals 2, united into a cap pushed off by the opening flower. Petals usually 4. Capsules slender, ribbed, 2-valved, dehiscent from base. Seeds rounded and elaborately sculptured. Western North America; 12 species.

1. Flowers mostly 1 per stalk (scape), the plants otherwise nearly stemless; floral receptacle with a ring-like winged rim; petals 15–40 mm long (may be smaller when drought-stunted); stamens 20 or more; capsules 4.7–8 cm long..... **Eschscholzia californica** subsp. **mexicana**
1. Stems of larger plants branched, leafy, and with several or more flowers; receptacle not winged; petals 3.2–8 mm long; stamens mostly fewer than 12; capsules 2.3–5 (6) cm long.
..... **Eschscholzia minutiflora**

Eschscholzia californica Chamisso subsp. **mexicana** (Greene) C. Clark
Mexican gold-poppy; *amapolita del campo*; ho:hi 'e'es. Figure 36.

Herbage and capsules bluish glaucous. Leaves mostly basal, 6–11 cm long. Flowering stalks usually 7–20 cm long and mostly leafless, 1-flowered, or with several 1-flowered branches or pedicels. Floral receptacles forming a cup with a spreading winged rim. Flowers showy, the petals, stamens, style, and stigma bright yellow-orange, the petals 15–40 mm long (as small as 7 mm when drought-stunted at end of season), the stamens 20–24. Capsules 4.7–8 cm long. Seeds 1.1–1.3 mm wide, similar to those of *E. minutiflora*.

Widespread in Arizona Upland areas of Organ Pipe including washes, roadsides, bajadas, canyons, and rocky slopes, and along the San Cristobal Wash in Cabeza Prieta.

Southeastern California to western Texas, southern Nevada, southwestern Utah, northern Sonora, both Baja California states, and northwestern Chihuahua.

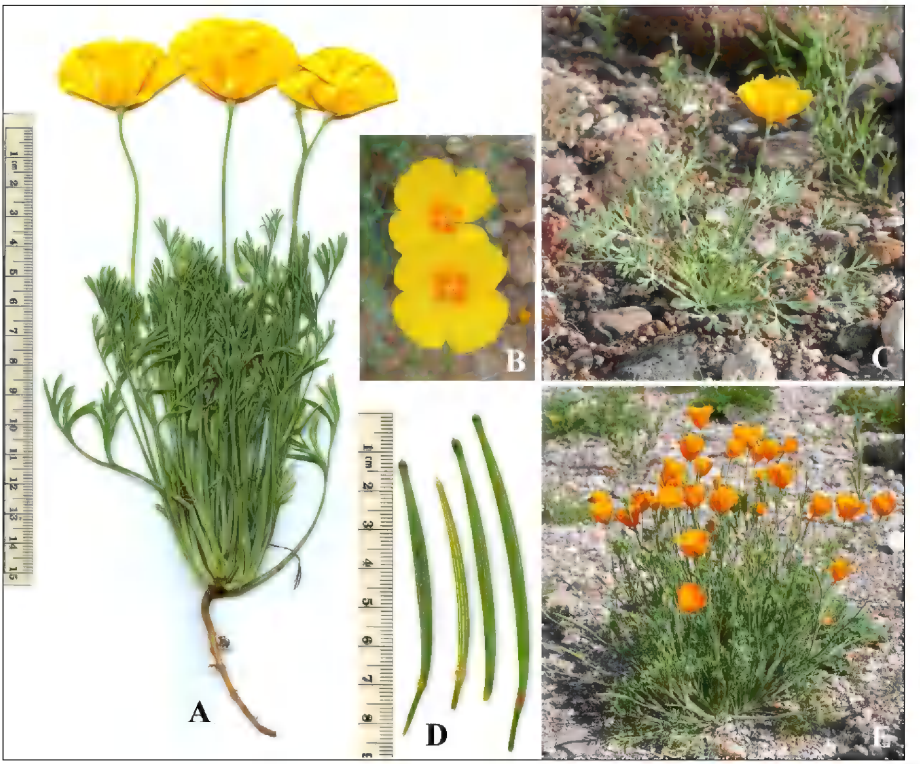

Figure 36. *Eschscholzia californica* subsp. *mexicana*. (A) Wash crossing Hwy 85 near N boundary of Organ Pipe, 14 Feb 2015. (B & D) N slope of the Puerto Blanco Mts, 12 Mar 2015. (C) Ten Mile Wash at Pipeline Road, NE of Ajo, 4 Mar 2009. (E) Coffeepot Mountain, Sikort Chuapo Mts, 27 Feb 2005.

Disjunct and separated by the intervening severe desert from the more western subsp. *californica,* which ranges from Washington to northwestern Baja California. This species probably extended its range in the Sonoran Desert region during glacial times and has been isolated by increasing aridity. The California or Mexican gold poppy is sometimes cultivated and often included in wildflower seed packages.

OP: Quitobaquito, *Nichol 10 Mar 1939* (the only record from the Quitobaquito area). Alamo Canyon, *Nichol 14 Mar 1939*. Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 556*. 0.6 mi E of Lukeville, 20 Feb 1988, *Felger 88-07*.

CP: San Cristobal Wash, 13 Mar 2014, *Rutman*, photo.

Eschscholzia minutiflora S. Watson
Little gold-poppy. Figure 37.

Herbage bluish glaucous, highly variable, the larger plants with multiple-flowered leafy-branched stems 15–45 cm long (much smaller on young or stunted plants). Leaves 3–11 cm long, reduced upward. Petals 3.2–8 mm long, yellow-orange. Stamens often 8–10. Capsules mostly 2.3–5 (6) cm long. Seeds globose, 1–1.2 mm wide, dark brown with a reticulate pattern of grayish white sac-like hairs swelling when wet.

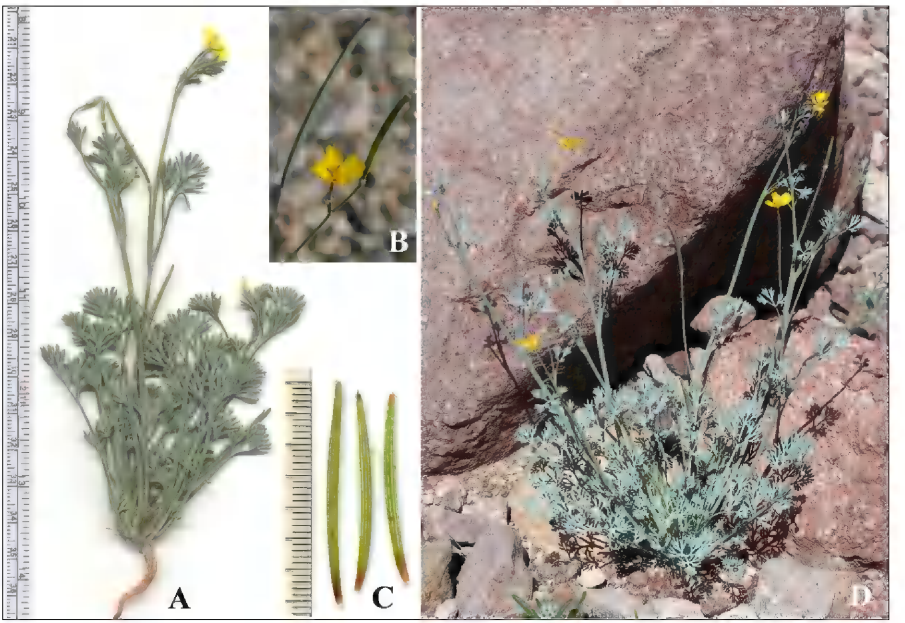

Figure 37. *Eschscholzia minutiflora*. (A) Near Bluebird Mine, 9 Mar 2014. (B) Eagle Tail Mountains Wilderness, Maricopa Co., 2 Apr 2008, photo by Elizabeth Makings. (C) Aguajita Wash near South Puerto Blanco Drive, 25 Feb 2015. (D) Estes Canyon near trailhead, 27 Feb 2014.

Widespread across the flora area in many habitats including washes, bajadas, plains, and rocky slopes. It is common from Tinajas Altas to the southwestern part of Organ Pipe and the Senita

Hills area, but also in Estes Canyon in the Ajo Mountains. Elsewhere in Organ Pipe is uncommon and localized. It seems to thrive best on granite-derived soils.

Southeastern California to Baja California Sur, southern Nevada, southwestern Utah, western Arizona, and northwestern Sonora.

OP: Victoria Pass near Burnham's Mine, *McDougall 8 Apr 1941.* Estes Canyon, 27 Mar 1966, *Niles 722.* Aguajita Wash, 6 Apr 1988, *Felger 88-290.* Large wash SW of Scarface Mt, 22 Mar 2003, *Rutman 2003-381.*

CP: Heart Tank, *Simmons 6 Mar 1964* (CAB). 1 km N of Tule Well, 11 Apr 1993, *Felger 93-440.*

TA: Vicinity of Tinajas Altas, *Van Devender 5 Mar 1983.* Tinajas Altas, canyon-wash just E of the tinajas, 28 Mar 2010, *Felger 10-188.* Surveyors Canyon, canyon bottom, 29 Mar 2010, *Felger 10-206.*

PHRYMACEAE – Monkey Flower Family (includes Scrophulariaceae, in part)

Annuals to herbaceous or woody perennials. Nearly worldwide; 13 genera, 188 species.

Erythranthe – Monkey-flower

Ephemerals (those in the flora area; also perennials elsewhere). Leaves opposite; stipules none. Flowers bilateral, in pairs from axils of opposite leaves or in bracteate racemes. Calyx often inflated, the sepals united into a strongly 5-angled or pleated tube, and 5-lobed. Corollas deciduous, slightly to strongly 2-lipped. Stamens 4, fertile. Fruits of capsules with numerous small seeds.

Americas and Asia; 111 species. *Erythranthe* is a genus segregated from *Mimulus* (Barker et al. 2012; Nesom 2012).

1. Flowers bright yellow, 1–2 cm long; calyx more than 8 mm long, becoming enlarged and inflated in fruit..... **Erythranthe cordata**
1. Flowers pink or yellow, less than 1 cm long; calyx 4–6 mm long, enlarging to less than 9 mm in fruit and not inflated..... **Erythranthe rubella**

Erythranthe cordata (Greene) G.L. Nesom

[*Mimulus cordatus* Greene. *M. guttatus* Fischer ex de Candolle, in part, misapplied]

Monkey flower. Figure 38.

Spring ephemerals (in the flora area), highly variable in size depending on water, several–30+ cm tall. Leaves often petioled below and sessile above, to ca. 15 cm long (usually much smaller), ovate to rounded, the margins toothed. Inflorescence racemose. Flowers pedicellate; calyx swollen in fruit; corollas often 1–1.5 cm long, bright yellow with red spots in the throat and lip. Capsules often 5–10+ mm long.

Waterholes, temporary pools, and puddles in canyons in the Ajo and Puerto Blanco mountains.

Generally in wetland habitats. Southwestern USA in Arizona, California, Colorado, Nevada, New Mexico, Texas, and Utah, and northwestern Mexico in Chihuahua, Coahuila, and Sonora.

"Plants of *Erythranthe cordata* vary greatly in size but are consistently distinguished from *E. guttata* sensu stricto in their small corollas, autogamous breeding, and lack of rhizome" (Nesom 2015: 1). *Erythranthe guttata* ranges from Alaska and Canada to northern Mexico (Nesom 2012, 2015), but does not extend into the core area of the Sonoran Desert.

Fresh leaves can be eaten like lettuce (Chestnut 1902; Yanovsky 1936). The young, tender leaves may have a mushroom-like flavor, especially when growing in the shade, but taste bitter when older or in harsher conditions.

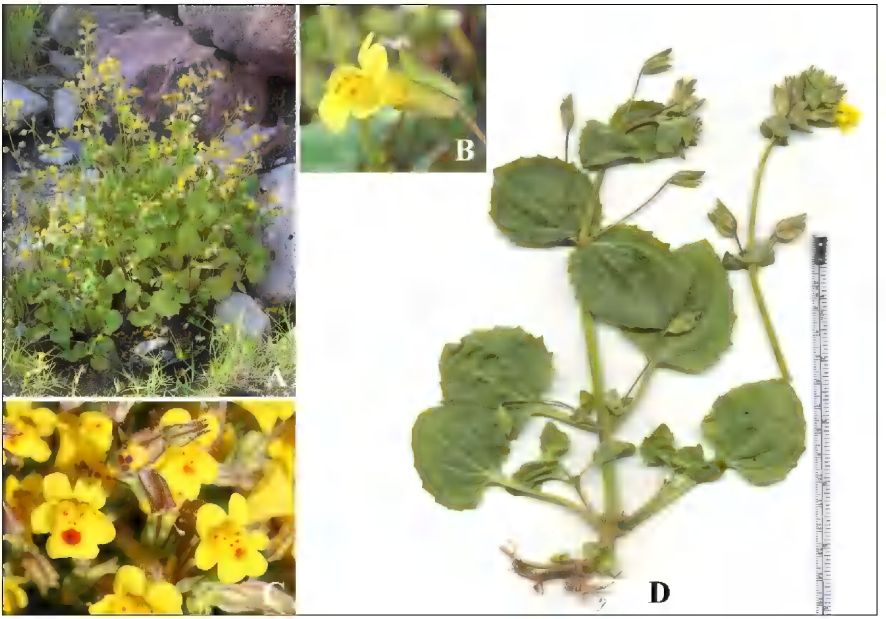

Figure 38. *Erythranthe cordata*. Alamo Canyon: (A) 4 Apr 2014; (B & D) 24 Mar 2008; (C) 26 Feb 2014.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Dripping Springs, 15 Apr 1952, *Cottam 12817*. Near Bull Pasture Spring, 3300 ft, 5 Apr 1978, *Bowers 1206*. Bull Pasture, 10 Apr 2005, *Felger 05-202*.

Erythranthe rubella (A. Gray) N.S. Fraga
[*Mimulus rubellus* A. Gray]
Little monkey-flower. Figure 39.

Diminutive winter-spring ephemerals, 1.5–8 cm tall. Herbage often reddish, sparsely short-haired. Leaves 5–10 mm long, the lower ones often broadly obovate, short petioled, the other leaves sessile and variable, including oblanceolate to obovate, elliptic, broadly ovate, or oval in shape; margins entire to broadly and bluntly shallow-toothed. Calyx cylindrical, slightly enlarging in fruits, 4–6 mm long, the lobes short and sparsely ciliate. Corollas protruding 4.5–6 mm from the calyx, corolla lobes notched, some populations with pink corollas, but mostly bright yellow with a maroon-red nectar guide, or the throat white with pink and the palate (the projecting part of the lower lip that closes the throat) yellow.

Locally in the Ajo Mountains and Gunsight Hills; washes and often moist microhabitats on rock slopes, and likely to be more widespread.

Southern California to Wyoming and New Mexico, both Baja California states, and northwestern Sonora.

OP: Alamo Canyon, damp sand, 19 Mar 1933, *Shreve 6202*. Alamo Canyon tributary just below crest of Ajo Mts, *Rutman 5 Mar 1998* (ORPI). Gunsight Hills, NE corner of Monument, *Rutman 4 Apr 1998* (ORPI).

Figure 39. *Erythranthe rubella*. Salero Ranch, Santa Cruz Co., 21 Mar 2014, photos by Sue Carnahan.

PHYTOLACCACEAE, *Rivina*, moved to **RIVINACEAE** (see Stevens 2012) in a forthcoming part of this flora series.

PLANTAGINACEAE – Plantain Family

Herbs and shrubs. Leaves opposite or alternate, sometimes in basal rosettes, simple, entire to dissected, without stipules. Flowers radial (*Plantago*) or bilateral. Calyx 4- or 5-lobed (the lobes often nearly separate and referred to here as sepals); corollas 4- or 5-lobed; stamens 2 or 4, and sometimes with a staminode. Fruit a capsule with numerous small seeds, or 2-seeded in *Plantago*.

Worldwide; 90 genera, 1900 species. Except for *Plantago*, those in the flora area were formerly included in Scrophulariaceae.

1. Shrubs; flowers bright yellow..... **Keckiella**
1. Ephemerals or herbaceous perennials, not shrubs; flowers various colors.

2. Leaves basal, the vegetative stems not developed or very short; corollas radially symmetrical or nearly so, papery, whitish to brown, and persistent; capsules with 2 seeds. ..... **Plantago**
2. Stems well developed; corollas bilaterally symmetrical, colorful, not papery, and often not persistent; capsules many seeded.

3. Plants vining or twining.

4. Stems often reaching 1+ m long; leaf blades triangular to triangular hastate-lobed, about as wide as long; corollas lavender-blue, 1.5–2 cm long..... **Maurandella**
4. Stems less than 1 m long; leaf blades linear to ovate, longer than wide; corollas 1–1.5 cm long, purple or yellow.

5. Corollas yellow, 1.5 mm long; capsules globose..... **Neogaerrhinum**
5. Corollas purple, 0.6–1 cm long, capsules ovoid .... **Sairocarpus**

3. Plants not vining.

6. Plants usually more than 40 cm tall; larger leaves more than 4 cm long; flowers at least 2 cm long, rose-pink or rose-purple..... **Penstemon**
6. Plants often less than 30 cm tall; flowers not more than 1.5 cm long and not rose-colored.

7. Plants glabrous; corollas blue, with a prominent, slender spur..... **Nuttallanthus**
7. Plants sparsely to densely pubescent, at least when young; corollas various colors, without a spur.

8. Leaves entire or toothed; calyx lobes 4; stamens 2 or 4; seeds not corky.

9. Leaves coarsely toothed; calyx 6–8 mm long; corollas dark blue, longer than the calyx; stamens 4; capsules ovoid..... **Stemodia**
9. Leaves entire to shallowly toothed; calyx 2–4 mm long; corollas white, shorter than the calyx; stamens 2; capsules flattened..... **Veronica**

8. Leaves entire; calyx lobes 5; stamens 4; seeds corky.

10. Herbage viscid-sticky; pedicels shorter than the flowers or fruit..... **Pseudorontium**
10. Herbage viscid-sticky or not; pedicels longer than the flowers or fruits.
..... **Sairocarpus**

Antirrhinum – Snapdragon

Antirrhinum sensu lato has been segregated into several genera (e.g., Vargas et al. 2004). See *Neogaerrhinum, Pseudorontium,* and *Sairocarpus.*

Keckiella – Bush penstemon

Arizona, Baja California, California, Nevada, and Sonora; 7 species. A genus segregated from *Penstemon.*

Keckiella antirrhinoides (Bentham) Straw subsp. **microphylla** (A. Gray) Straw
[*Penstemon microphyllus* A. Gray. *P. antirrhinoides* Bentham subsp. *microphyllus* (A. Gray) D.D. Keck. *Keckia antirrhinoides* (Bentham) Straw subsp. *microphylla* (A. Gray) Straw]
Desert bush-penstemon. Figure 41.

Woody shrubs to 1.5 m tall, much branched, the stems slender and brittle, often branching at right angles. Bark light tan. Leaves opposite, petioles short or leaves sessile, mostly 1.5–3 cm long, more or less ovate, thick, canescent with sparse to moderately dense pubescence of short hairs; leaf margins entire; facultatively and gradually drought deciduous. Flowers showy; calyx lobes 5, acute; corollas bright yellow, 1.5–2+ cm long; stamens 4 plus a bearded staminode. Dry, dead capsules persistent; seeds many. Flowering at least April and May and in October.

Figure 41. *Keckiella antirrhinoides* subsp. *microphylla*. Near Indian Cove Campground, Joshua Tree National Park, San Bernardino Co., California, 30 Apr 2012.

Rocky slopes and canyons at higher elevations in the Ajo Mountains, often below north-facing cliffs, and one record from the Growler Mountains in Cabeza Prieta.

Western and central Arizona, southeastern California, Nevada, both states of Baja California, and mountain tops in northwestern Sonora. This is the only member of *Keckiella* that occurs inland and east of the western part of California and Baja California. Replaced by subsp. *antirrhinoides* in southwestern California and northwestern Baja.

OP: Arch Canyon, *Fouts* 2 May 1948 (ORPI). Boulder Canyon, 3000 ft, 3 May 1978, *Bowers 1281*. Alamo Wash, 31 Mar 1989, *Wilson 209*.
CP: Growler Mts, vicinity of Growler Peak, just N of Charlie Bell Pass, 302775 E, 3587989 N, *Peter Holm 4 April 2014*.

Maurandella

Southwestern USA and Mexico; 2 species. A genus segregated from *Maurandya*.

Maurandella antirrhiniflora (Humboldt & Bonpland ex Willdenow) Rothmaler
[*Maurandya antirrhiniflora* Humboldt & Bonpland ex Willdenow. *Asarina antirrhiniflora* (Humboldt & Bonpland ex Willdenow) Pennell]
Blue snapdragon-vine, blue twining snapdragon. Figure 42.

Ephemerals or annuals, or perhaps perennials (perennials elsewhere). Vines climbing into shrubs and trees such as mesquite; sometimes forming a curtain of slender, intertwining stems; essentially glabrous. Petioles and pedicels often curved and loosely twining. Leaves alternate, larger

leaves often 2–3 (4.5) cm long, the blades triangular and hastate-lobed. Flowers snapdragon-like, solitary from leaf axils, often 1.5–2 cm long (to 3 cm elsewhere). Sepals 5, linear-acute, persistent in fruit. Corollas lavender-blue, 2-lipped; the base of the lower lip swollen, white with lavender-blue speckles forming nectar guide-lines and with white hairs. Stamens 4, the filaments hairy at base. Capsules globose, dehiscent irregularly from near the tip; seeds numerous. Variously growing and flowering spring, summer, and fall.

Figure 42. *Maurandella antirrhiniflora.* (A) Kuakatch Wash near E boundary of Organ Pipe, 25 Aug 2008. (B) Josephine Canyon, Santa Rita Mts, Santa Cruz Co., 11 May 2013; (C) Salero Ranch, Santa Cruz Co., 12 May 2014; photos by Sue Carnahan. (D) Kuakatch Wash near E boundary of Organ Pipe, 7 Oct 2014. (E) Alamo Wash near Hwy 85, 22 Mar 2015.

Washes and canyons, widely scattered but seldom common; eastern part of Cabeza Prieta and Organ Pipe mostly in the northern and eastern part, and not in the drier, southwestern portion of the Monument.

Southern California to Texas, and northern Sonora to Coahuila and Puebla.

OP: Growler Wash, 13 Apr 1941, *McDougall 92.* 2 mi SE of Walls Well, 30 Aug 1945, *Gould 3221.* Bull Pasture Trail, 5 Nov 1977, *Bowers 933.* Wash just E of Visitor Center, *Van Devender 30 Aug 1978* (ORPI). Confluence of Alamo and Cherioni washes, *Warren 10 Nov 1983.*
CP: Daniels Arroyo, 1 mi N of Lower Well, 12 Jun 1992, *Felger 92-544.* Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-351.*

Neogaerrhinum

Southwestern USA, Baja California, and Sonora; 2 species. A genus segregated from *Antirrhinum.*

Neogaerrhinum filipes (A. Gray) Rothmaler
[*Antirrhinum filipes* A. Gray. *Asarina filipes* (A. Gray) Pennell]
Yellow twining-snapdragon. Figure 43.

Winter-spring ephemerals. Seedlings and young plants or lower stems sparsely to densely villous with white hairs, the stems and leaves otherwise glabrate. Stems slender with long internodes, climbing on shrubs by means of elongated, prehensile pedicels. Leaves opposite at base, alternate above, the blades broadly lanceolate to ovate at the lower nodes, narrower upward (linear-lanceolate to linear); larger leaves (1.5) 3–5 cm long, the petioles conspicuous. Pedicels very slender, often 4–6+ cm long, twining like a tendril when contacting other stems, even those of the same plant, or twigs, cactus spines, etc. Flowers snapdragon-like, bilateral with glandular hairs and sparse non-glandular white hairs. Corollas 1.5 cm long, 2-lipped, bright yellow. Capsules 5 mm long, globose, dehiscing irregularly. Seeds numerous, whitish, becoming dark brown with age, 1.1–1.5 mm long, with several thickened, parallel ridge-like wings on one side, the body irregularly tuberculate on the other side.

Figure 43. *Neogaerrhinum filipes*. (A & B) Senita Basin, 18 Mar 2005. (C) Joshua Tree National Park, San Bernardino Co., California, 10 Apr 2009, photo by Keir Morse (CalPhotos).

Infrequent along washes, canyons, and rocky slopes; widely scattered in Organ Pipe and one record in the eastern part of Cabeza Prieta.

Northwestern Sonora, western Arizona, southeastern California, southern Nevada, and southwestern Utah.

OP: Alamo Canyon, 14 Mar 1941, *Benson 19669* (RSA). Senita Pass, 13 Apr 1941, *McDougall 84.* Quitobaquito, 29 Mar 1988, *Felger 88-124.* Hills N of Puerto Blanco Mts, *Rutman 7 Apr 1998* (ORPI). Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-251* (ORPI).
CP: Chico Suni Wash, 2 Feb 2003, *Rutman 2003-27.*

Nuttallanthus
Annual and biennial herbs. North and South America; 4 species.

Nuttallanthus texanus (Scheele) D.A. Sutton
[*Linaria texana* Scheele. *L. canadensis* (Linnaeus) Dumont de Courset var. *texana* (Scheele) Pennell]
Texas toadflax, blue toadflax. Figure 44.

Winter-spring ephemerals; what appears to be a basal rosette of pinnate leaves is a rosette of short, non-flowering, leafy stems that usually wither by flowering time (elsewhere these stems may develop into flowering stems). Lower leaves opposite, 4–20 mm long; upper stem leaves alternate, sessile, linear and glandular-punctate, the plants often leafless or nearly so by flowering time. Flowering stems often 15–25+ cm tall, one or occasionally several, erect and slender. Inflorescences racemose, compact and elongating in fruit, with a bract beneath each flower. Flowers blue and attractive, bilaterally symmetrical; corollas 8 mm long plus a conspicuous nectar-filled spur that attracts insects, the corolla lip serving as a landing pad. Stamens 4. Capsules rounded, 3 mm wide, opening by terminal slits. Seeds many.

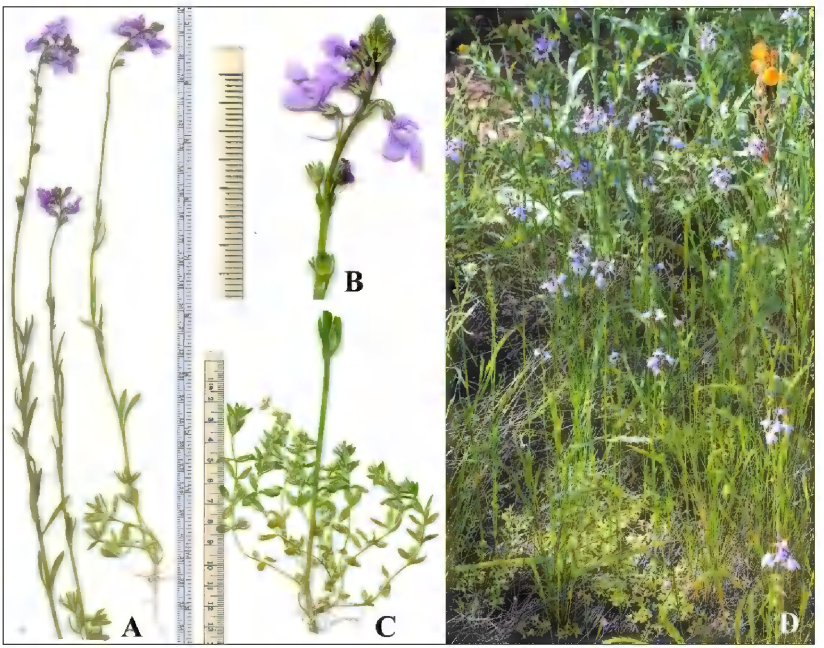

Figure 44. *Nuttallanthus texanus*. (A) Estes Canyon, 2 Mar 2008. (B–D) Sandy wash near Hwy 85, N end of Organ Pipe, 25 Feb 2014.

Organ Pipe in the Ajo and Diablo mountains and sand flats in the northern part of the Monument; washes, canyon bottoms, and rocky slopes and ledges.

Canada to central Mexico and temperate South America.

OP: Arch Canyon, *Dakan 13 Jan 1973* (ORPI). NW of Montezuma's Head, 2000 ft, *Van Devender 10 Mar 1978*. Bull Pasture, 28 Feb 1989, *Baker 7708* (ORPI). Wild Horse Canyon, 2400 ft, *Rutman 9 Mar 2001* (ORPI). Armenta Road 1.4 mi W of Ariz Hwy 85, 11 Mar 2003, *Felger 03-248*.

Penstemon – Beard tongue

Herbaceous perennials, probably short-lived (those in the flora area), occasionally facultative ephemerals. Leaves opposite, at first sometimes in a basal rosette, the upper leaves rarely alternate; leaf margins toothed or entire; lower leaves often petioled, the upper ones sessile. Inflorescences of oppositely branched panicles or racemes, the flowers subtended by usually conspicuous bracts. Sepals 5, nearly separate. Corollas showy, moderately to strongly 2-lipped. Fertile stamens 4, the fifth a sterile staminode, usually bearded (the "beard tongue"); nectaries of glandular hairs on the filaments. Capsules firm. Seeds numerous, irregularly angled. One or more *Penstemon* species were present in the region 11,000 years ago.

North America; 250 species—this is the largest genus of flowering plants endemic to North America.

1. Leaf margins entire, the upper leaves separate at their base..... **Penstemon parryi**
1. Leaf margins toothed, the upper leaves joined at their base..... **Penstemon pseudospectabilis**

Penstemon parryi (A. Gray) A. Gray
Desert penstemon; *jaritos, varita de San José*; hevel 'e'es. Figure 45.

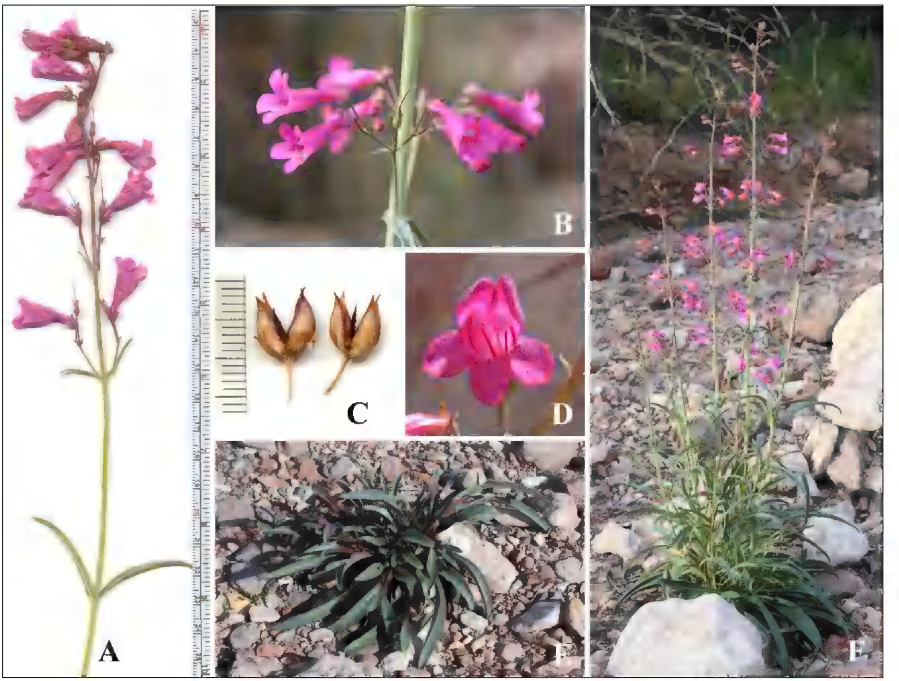

Figure 45. *Penstemon parryi*. (A) Kuakatch Wash near E boundary of Organ Pipe, 21 Mar 2008. (B) Pomeroy Wash at Pipeline Road, Sikort Chuapo Mts, 4 Mar 2009. (C) Diablo Mts near Ajo Mountain Drive, 17 May 2015. (D) Santa Catalina Mountains, 29 Mar 2014. (E) Alamo Wash, 28 Dec 2013. (F) Estes Canyon, 30 Jan 2014.

Perennials, or functioning as winter-spring ephemerals in the drier areas, taller stems 45–60+ cm. Herbage glaucous and glabrous. Early leaves in a basal rosette. Leaves entire, mostly lanceolate to elliptic, the lower leaves petioled, the larger leaves 5–12+ cm long, the upper leaves sessile and narrowed. Flowers on erect, slender, raceme-like panicles. Corollas 2 cm long, bright rose-pink. Staminode bearded with yellow hiars. Capsules 7–9 mm long. Seeds 1.1–1.8 mm long, dark red-brown, minutely tuberculate (appearing beaded), irregularly angled due to the developing seeds pressing on one another.

Widespread in Organ Pipe including higher elevations and rare on Childs Mountain. Expected in the northern and eastern margins of Cabeza Prieta and rare in the Tinajas Altas Mountains.

Southern Arizona and northwestern and eastern Sonora.

OP: Cipriano Well, *Nichol 27 Apr 1939.* Quitobaquito, 30 Nov 1939, *Harbison 26195.* Alamo Canyon, 3600 ft, *Tinkham 19 Apr 1942.* 1.5 mi E of Bates Well, 18 Mar 1945, *Gould 3006.* The Cones, on trail to Mount Ajo, 3565 ft, 10 Apr 2005, *Felger 05-240.*

CP: Childs Mt, cliff ridge near tower (summit), one plant seen, Mar 2004, *Curtis McCasland* (observation).

TA: Tinajas Altas, wash just below the lower tank, rare, 10 Jan 2002, *Felger* (observation).

Penstemon pseudospectabilis M.E. Jones subsp. **pseudospectabilis**
Mojave beard-tongue. Figure 46.

Herbaceous perennials often 0.5–1+ m tall, also flowering in the first year. Stems and leaves glaucous and glabrous. Larger leaves 7–16.5+ × 3.3–5 cm, broadly ovate, to triangular ovate above, the margins coarsely toothed; lower leaves petioled and separate, the middle ones sessile, and the upper leaves connate (leaves of the opposite pair joined at their bases). Pedicels, calyces, and corollas sparsely to moderately glandular hairy. Corollas bright rose-purple, 2.5–3 cm long. Staminode glabrous or sparsely bearded with glandular hairs. Capsules 10–14 mm long. Flowering during cooler months, from mid-October but mostly February–April.

Mountains in the eastern part of Organ Pipe, and locally and mostly in canyons and at higher elevations in the western part of the flora area.

This species occurs in Arizona, southeastern California, southern Nevada, southwestern New Mexico, and northern Sonora. The western populations are subsp. *pseudospectabilis.*

OP: Arch Canyon, 3500 ft, 28 Mar 1965, *Lockwood 161.* Grass Canyon, 2600 ft, 26 Feb 1978, *Bowers 1091.*

CP: Major ravine N of Eagle Tank (Simmons 1966). Large wash below Heart Tank, locally rare, 27 Feb 1993, *Felger 93-160.* Cabeza Prieta Peak, 2550 ft, N-facing side of summit, 14 Mar 1995, *Yeatts 3648* (CAB).

TA: Tinajas Altas, frequent in wash above tanks, 487 m, 8 Mar 1984, *Hodgson 2723* (DES). Frontera Canyon, 18 Mar 1998, *Felger* (observation). Canyon above Tinajas Altas, canyon bottom and lower N-facing slopes among rocks, 26 Oct 2004, *Felger 04-77.*

†**Penstemon** sp.

TA: †Tinajas Altas, fruits, 10,950 & 11,040 ybp.

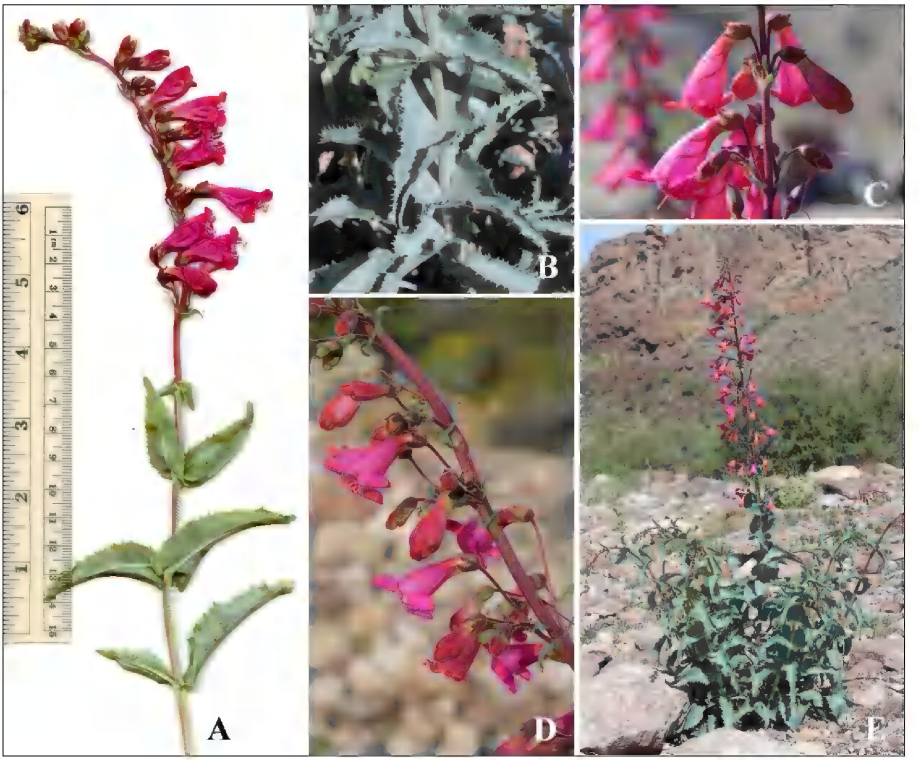

Figure 46. *Penstemon pseudospectabilis* subsp. *pseudospectabilis*. Estes Canyon: (A) 17 May 2015; (B & C) 27 Feb 2014; (D & E) 13 Jan 2014.

Plantago – Plantain

Those in the flora area: Small, winter-spring ephemerals. Vegetative stems very short, commonly appearing stemless. Leaves in close spirals resembling a basal rosette, slender and parallel veined. Flowering stems slender and leafless. Flowers in spikes, usually wind-pollinated, radially symmetrical or nearly so, and 4-merous. Sepals green or papery, the corollas papery, straw-colored, and persistent. Capsule opening around the middle (circumscissile), 2-seeded. When water contacts the seed coat it quickly forms a jacket of slime (mucilage) that on drying tenaciously glues the seed to any available substrate.

Annual and perennial herbs. Worldwide; 250 species.

1. Bracts broadly ovate to obovate, with broad papery-membranous margins, none longer than the sepals; seeds shiny..... **Plantago ovata**
1. Bracts linear to narrowly oblong, all green (or sometimes with minute membranous wings at base), the bracts of the lower flowers usually much longer than the sepals; seeds dull...**Plantago patagonica**

Plantago ovata Forsskål var. **fastigiata** (E. Morris) S.C. Meyers & Liston
[*P. insularis* Eastwood. *P. fastigiata* E. Morris. *P. insularis* var. *fastigiata* (E. Morris) Jepson, not *P. insularis* Nyman ex Briquet]
Woolly plantain, Indian wheat; *pastora*; mumsa. Figure 47.

Winter-spring ephemerals, highly variable in size depending on soil moisture, usually with a well-developed slender taproot. Herbage, flowering stems, and inflorescences moderately to densely pubescent with loosely woolly and silky silvery-white hairs. Cotyledons narrow-linear, dark brown when dry and often persistent. Plants generally appearing stemless, but sometimes forming a short, leafy stem occasionally reaching 7.5 cm tall. Leaves (4) 5–17 cm × 1–10 mm, erect to ascending or spreading, linear to linear-lanceolate, gradually narrowed below to a winged petiole; margins entire.

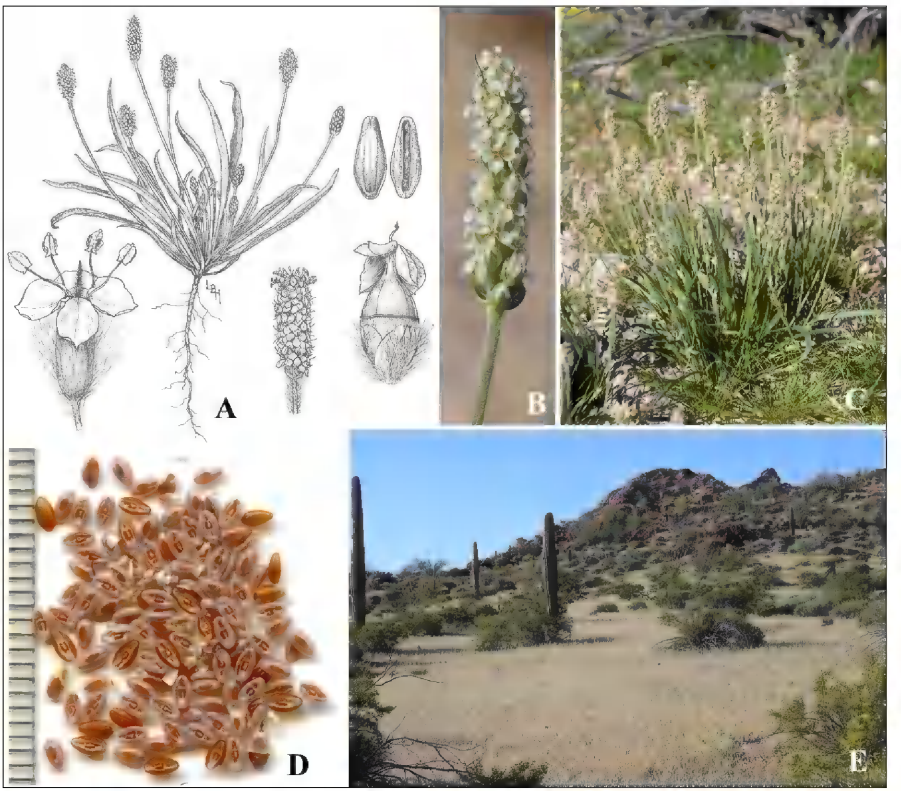

Figure 47. *Plantago ovata* var. *fastigiata*. (A) By Lucretia Breazeale Hamilton. (B) Estes Canyon, 27 Feb 2014. (C) W of Quitobaquito, along U.S./Mex border, 5 Feb 2005. (D) 11 mi E of Why, Hwy 86 at mile 62, 5 Apr 2015. (E) Red Tanks parking area, North Puerto Blanco Drive, 15 Mar 2015.

There is considerable variation in plant size, leaf width, and pubescence (Felger 2000). Plants from the most arid southwestern corner of the flora area and the Gran Desierto dunes in Sonora often have especially narrow leaves, often only 1–1.5 mm wide. Drought-stressed plants can be as

small as 6.4–12 mm tall, with persistent cotyledons to 12 mm long, only two leaves 7 mm long, and a peduncle bearing a single flower and fruit.

Flowering stems (peduncle or scape plus spike) usually several or more per plant, erect to ascending, (3) 4–20 (30) cm tall, leafless, mostly many-flowered. Flowers and bracts straw-colored and papery. Floral bracts 2.5–3 mm long, broadly ovate to slightly obovate, with a thickened green midstripe and broad, papery-membranous white margins; the bracts and sepals similar. Flowers protogynous (the stigma protrudes from the unopened corolla before the stamens expand). Corollas membranous-papery and brown, the lobes broad and spreading. Fresh, young flowers, however, have transparent white or pale pink corolla lobes, and the style and stigma are reddish lavender. Stamens quivering in the slightest breeze; filaments lavender, the anthers cream-white. Seeds (1.8) 2.1–2.5 (2.7) mm long, 2 per capsule, ellipsoid, shiny yellowish- or reddish-brown, the outer face convex, the inner face flat and excavated.

Abundant and widespread, especially well developed on sandy soils including dunes, and desert plains and valleys, hills, and at least most mountains to their summits. This species has been in the region for at least 20,500 years, although the infraspecific status of the fossils has not been determined. Bassett and Baum (1969) claimed the North American population resulted from Old World introduction by California settlers in the late 18th and early 19th centuries, and a number of authors continued to parrot this claim.

Variety *fastigiata* is the inland North American variety in southwestern USA and northern Mexico, and one of the most common and widespread winter-spring ephemerals of the Sonoran Desert. Other varieties occur in western North America and the Old World (Meyers & Liston 2008). *Plantago ovata* is the only known species within the Plantaginaceae having the basic chromosome number 4; other species have 5 or 6. Of the species belonging to *Plantago* section *Albicans, P. ovata* is the only one also found outside the Old World (Rahn 1979).

The seeds probably were eaten by all Sonoran Desert people (Hodgson 2001). The seeds were boiled, parched and ground into flour, or often merely soaked in water and consumed as a beverage or eaten as a gelatin-like mass (Felger 2007; Felger & Moser 1985). In favorable years it is abundant in spring and could be a significant food source. The seeds were also widely used medicinally. Commercial psyllium seed derives from cultivated varieties or forms of Old World *P. ovata* and *P. psyllium*.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939*. Alamo Canyon, 3000 ft, 14 Mar 1941, *Benson 10683*. Dripping Springs, 15 Apr 1952, *Parker 7908*. 6 mi E of Hwy 85 on Camino Dos Republicas, 11 Feb 1978, *Bowers 1039*. Aguajita Wash, 19 Jun 1989, *Felger 89-261* (ORPI). Armenta Road 1.4 mi W of Ariz Hwy 85, 11 Mar 2003, *Felger 03-256*. W side of Sierra Santa Rosa, along border, 12 Mar 2003, *Felger 03-373* (ASU). †Alamo Canyon, seeds, 1150 ybp. †Montezuma's Head, seeds, 20,490 ybp.

CP: Pinta Sands, 1 Feb 1992, *Felger 92-25*. Near Tule Well, 19 Mar 1992, *Yeatts 3228* (CAB). Charlie Bell Pass, 3 Apr 1992, *Whipple 3923*. Charlie Bell Road near east Refuge boundary, 9 Apr 1993, *Felger 93-320*.

TA: Above the tinajas, 19 Mar 1998, *Felger* (observation). Coyote Water, 21 Feb 2005, *Felger 05-123*. †Butler Mts, seeds, 740 to 11,250 ybp (6 samples).

Plantago patagonica Jacquin
[*P. purshii* Roemer & Schultes. *P. purshii* var. *oblongata* (E. Morris) Shinners]
Pastora. Figure 48.

Winter-spring ephemerals somewhat resembling *P. ovata*. Herbage with tawny brown hairs. Leaves linear to linear-lanceolate, often 2–8 (12) cm long. Flowering stems leafless, erect to ascending, often (6) 9–20 (27) cm tall. Bracts green or sometimes with minute membranous wings

near the base, linear to nearly oblong, the bracts subtending the lower flowers often more than twice as long as the sepals, becoming shorter on upper flowers; mid-spike bracts 3.5–5 (6) mm long. Flowers cleistogamous (self-pollinating in the bud, the anthers not exserted beyond the corolla mouth). Corollas moderately bilateral. Seeds 3 mm long, 2 per capsule, dull dark brown.

Widespread, valleys to rocky slopes across Organ Pipe except the southwestern part; Ajo Mountains westward to the eastern part of Cabeza Prieta.

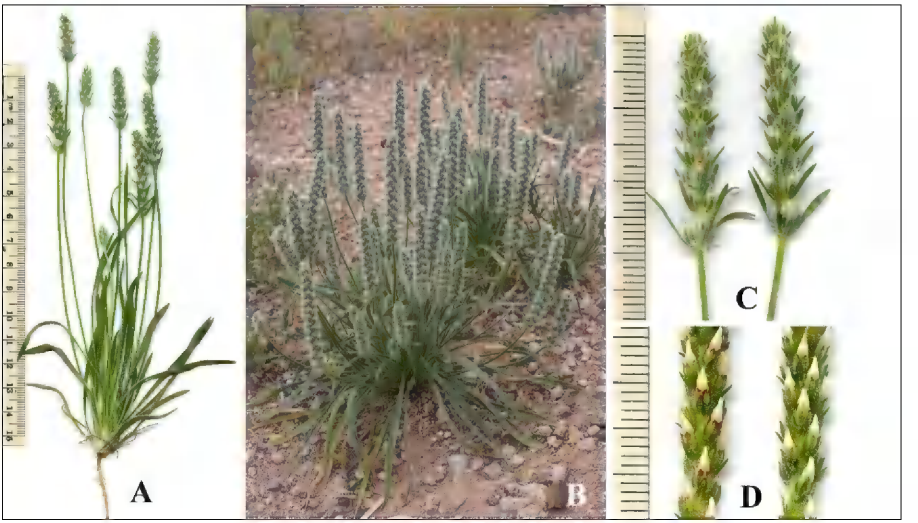

Figure 48. *Plantago patagonica*. (A & C) Wash crossing Hwy 85, N boundary of Organ Pipe, 25 Feb 2015. (B) Javelina Mountain, Sauceda Mts, 3 Apr 2005. (D) 11 mi E of Why, Hwy 86 at mile 62, 5 Apr 2015.

Western North America from Canada to northern Mexico and introduced farther east, and disjunct in Argentina and Chile.

The seeds were used in similar ways as those of *P. ovata* (Hodgson 2001), but *P. patagonica* is not as widespread or common in the Sonoran Desert.

OP: Alamo Canyon, 14 Mar 1941, *Benson 10683*. Near Arch Canyon, 28 Mar 1965, *Niles 558*. San Cristobal Wash near W boundary, 20 Mar 2003, *Rutman 2003-370*. Floodplain near N end of Pozo Nuevo Hills, 11 Apr 2003, *Rutman 2003-454*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation).

CP: Jose Juan Represo, 12 Jun 1992, *Felger 92-560*. San Cristobal Wash at Camino del Diablo, 10 Apr 1993, *Felger 93-377*.

Pseudorontium

One species; a genus segregated from *Antirrhinum*.

Pseudorontium cyathiferum (Bentham) Rothmaler
[*Antirrhinum cyathiferum* Bentham]
Desert snapdragon, dog's mouth. Figure 49.

Figure 49. *Pseudorontium cyathiferum.* (A, C–F) Sandy wash, S side of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015. (B) N of Mulegé, Baja California Sur, 25 Oct 2006, photo by Patrick Alexander (SEINet).

Non-seasonal ephemerals, 3–25 cm tall, viscid (sticky) glandular hairy and foul smelling; often with more than one major stem and branched mostly from the lower half of the plant. Leaves opposite at lower 1 or 2 nodes, alternate and usually gradually smaller upwards; prominently petioled; leaf blades ovate to broadly lanceolate, often with apical glands (dark purplish areas); larger leaves 1.5–4 (5.5) × 0.8–1.6 cm. Pedicels shorter than the flowers or fruit, turning downward, inverting the fruit. Corollas 1 cm long, purple-blue with darker veins, the lip with 2 yellow spots and hairy at the entrance to the throat. Capsules globose. Seeds many, 1.9–2.5 mm long, whitish, becoming dark brown with age, with a wide cup-shaped wing surmounted by a linear body 1.5–1.7 mm long and tuberculate on irregular ridges.

Washes, bajadas, canyons, and slopes; widespread across the region but seldom common.

Sonoran Desert in southwestern Arizona, southeastern California, both Baja California states, and Sonora.

OP: Quitobaquito, 27 Nov 1939, *Harbison 26182* (SD). Senita Basin, 2 Mar 1989, *Baker 7715* (ASU, ORPI). Alamo Canyon, 15 Mar 2003, *Rutman 2003-325* (ORPI). NE slope of Pinkley Peak, *Rutman 31 Oct 2003* (ORPI).

CP: 26 mi W of Papago Well, Tule Mts, 1000 ft, 15 Apr 1940, *Benson 10792.* Near Tule Well: 20 Mar 1992, *Yeatts 3236* (CAB); 23 Mar 2002, *Harlan 512.* Cabeza Prieta Tanks, 15 Jun 1992, *Felger* (observation).

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation). Tinajas Altas Pass, 2 Mar 2014, *Sue Carnahan*, photo.

Sairocarpus – Snapdragon

Winter-spring ephemerals. Branchlets often twining. Leaves alternate, except lowermost leaves opposite. Flowers small and snapdragon-like. Capsules ovoid with many seeds.

At least a dozen species in southwestern USA and northwestern Mexico. A genus segregated from *Antirrhinum* (Barringer 2013, and in press).

1. Plants glandular-pubescent; leaves mostly ovate; pedicels mostly not longer than the flowers ..... **Sairocarpus nuttallianus**
1. Plants glabrous or essentially so (except sparsely pubescent at base); leaves mostly linear or nearly so; pedicels mostly longer than the flowers ..... **Sairocarpus watsonii**

Sairocarpus nuttallianus (Bentham) D.A. Sutton

[*Antirrhinum nuttallianum* Bentham subsp. *subsessile* (A. Gray) D.M. Thompson. *A. nuttallianum* var. *subsessile* (A. Gray) Jepson. *A. pusillum* Brandegee]

Lesser snapdragon, violet snapdragon. Figure 50.

Plants glandular-pubescent; usually with a single main axis and only short branches from above the approximate mid-height of the plant. The glandular-sticky stems often stick together in wind or when collected. Larger plants usually with some prehensile, or twining, branchlets. Leaves 0.5–3+ cm long, petioled, the blades ovate. Some plants may have exclusively chasmogamous flowers, the corollas about 1 cm long, violet-purple, the lower lip (palate) with two (sometimes confluent) whitish patches with purple venation, the tube with purple veins; other plants may have chasmogamous and cleistogamous flowers.

Ajo Mountains in canyons and rocky slopes to higher elevations and sometimes extending westward along major washes to the desert floor in the vicinity of Hwy 85.

Southern and central Arizona, expected in northern Sonora, and disjunct in Pacific southern California to Baja California Sur.

OP: Arch Canyon, 5 Apr 1978, *Bowers 1174* (ORPI). Junction Ajo Mt Drive with Boulder Canyon, 18 Apr 1983, *Thompson 264.* Alamo Canyon bridge on Hwy 85, *Rutman 4 Apr 2001* (ORPI). Alamo Canyon, 29 Mar 2003, *Felger 03-413.* Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-272.*

Figure 50. *Sairocarpus nuttallianus*. Salero Ranch, Santa Cruz Co., photos by Sue Carnahan: (A) 31 Mar 2012; (B) 1 Apr 2013; (C) 16 Apr 2015.

Sairocarpus watsonii (Vasey & Rose) D.A. Sutton
[*Antirrhinum watsonii* Vasey & Rose. *A. kingii* S. Watson var. *watsonii* (Vasey & Rose) Munz]
Watson's snapdragon. Figure 51.

Plants with delicate stems, the larger plants often with slender, twining branchlets; often sparsely pubescent at the base with glandular hairs, and glabrous or essentially so above. Leaves linear or nearly so, mostly 1–4+ cm long. Pedicels longer than the flowers. Corollas 6–7 mm long, bluish purple to dark purple with the lower lip (palate) white striped with purple, or the first flowers often cleistogamous with highly reduced, whitish corollas.

In the USA known only from Organ Pipe, in the Ajo Mountains and westward to the vicinity of the Monument headquarters. Otherwise mainly along the Sonora coast from the vicinity of Guaymas to Puerto Lobos and the Sierra Viejo near Caborca, islands in the Gulf of California, and much of the Baja California Peninsula.

OP: Between Diaz Mt and Sweetwater Wash, *Schmitt 24 Feb 1973* (ORPI). 2 mi W of Sweetwater Pass [northern Sonoyta Valley], 31°59'25"N, 112°41' 55"W, 640 m, E-facing hillside, near or under shrubs, weak annual with prehensile lateral shoots, flowers blue-lavender with white center, 1 Mar 1989, *Baker 7707* (ASU, ORPI; cited by D.J. Pinkava et al, 1992, J. AZ-Nev. Acad. Sci. 24/25: 17). Estes Canyon, *Rutman 15 Mar 1998* (ORPI). 0.5 mi E of main campground [near visitor center], rocky slopes of S-facing hill, *Rutman 31 Mar 1998* (ORPI).

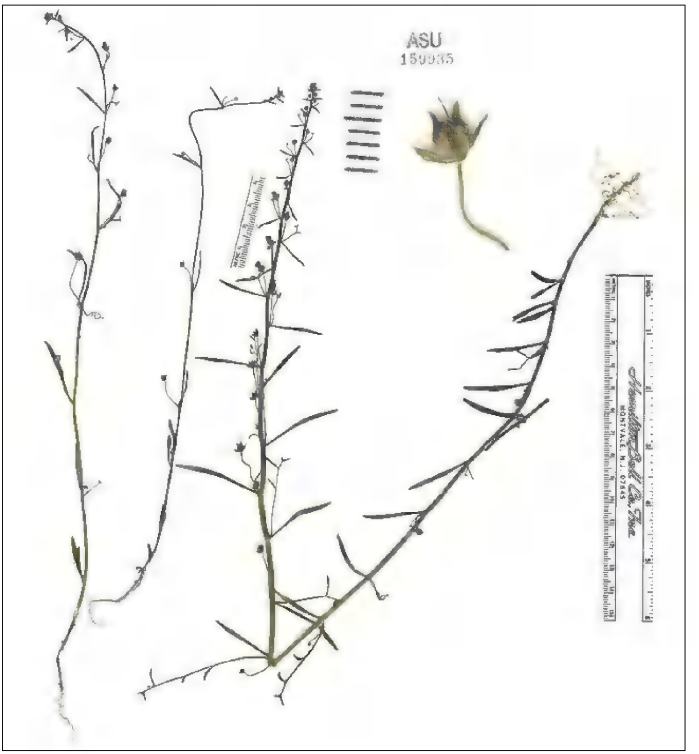

Figure 51. *Sairocarpus watsonii.* E-facing hillside, northern Sonoyta Valley, with *Ambrosia deltoidea, Carnegiea gigantea, Calliandra, Coursetia*, and *Simmondsia*, 1 Mar 1989, *Baker 7707* (ASU 159935).

Stemodia

Mostly perennial herbs and some shrubs; worldwide; 50 species.

Stemodia durantifolia (Linnaeus) Swartz

Purple stemodia. Figure 52.

Herbaceous perennials, also flowering in the first season, stems usually erect, to 30–40 tall; glandular pubescent. Leaves opposite, larger leaves often 8–15 mm long, the first leaves in a basal rosette, upper stem leaves reduced; leaf margins serrated. Pedicels 1–6 mm long; sepals 6–8 mm long; corollas 8–10 mm long, dark blue. Capsules ovoid; seeds many.

In the flora area known only from several records at water's edge in the bottom of Alamo Canyon.

Southwestern USA and tropical America.

OP: Alamo Canyon: Wash, *Dakan 2 Feb 1972* (ORPI); Wash bed of S fork of Alamo Canyon, next to a pool, 7 Sep 2013, *Rutman 20130907-5.*

Figure 52. *Stemodia durantifolia*. Alamo Canyon near Alamo Well: (A) 9 Sep 2013; (B) 11 Mar 2014. (C) King Canyon, Tucson Mts, 21 Feb 2009, photo by Patrick Alexander (SEINet). (D) Sabino Canyon, Santa Catalina Mts, Aug 2011, photo by Anthony Mendoza (SEINet).

Veronica

Northern Hemisphere, especially Eurasia; 250 species.

Veronica peregrina Linnaeus subsp. **xalapensis** (Kunth) Pennell
Purslane speedwell, necklace-weed. Figure 53.

Delicate winter-spring ephemerals, (6) 10–30 cm tall. Leaves and lower stems glabrate, the upper stems with slender stalked glands. Leaves opposite, 6–24 mm long, usually deciduous by fruiting time, oblong to elliptic or oblanceolate, the margins entire to shallowly toothed. Racemes elongated, mostly terminal, reaching 15–25 cm on larger plants, the floral bracts alternate and gradually reduced upwards. Pedicels short. Flowers minute and inconspicuous. Sepals 4, fruiting sepals 2.5–4 mm long. Corollas and stamens white, the corollas smaller than the calyx. Stamens 2. Capsules obcordate, 3–4 mm wide, distinctly flattened, wider than long. Seeds yellow-orange, many, (0.6) 0.7 (0.8) mm long, smooth, flattened on one side, ridged on the other side.

Locally on wet soil at charcos, tinajas, and canyon-bottom waterholes and puddles, sometimes abundant at the large playas in Cabeza Prieta, and formerly bordering the pond at Quitobaquito.

This subspecies ranges from Alaska and Canada to Central America and South America. Another subspecies occurs in temperate North America and Eurasia.

Figure 53. *Veronica peregrina*. (A) Pinacate Junction, Pinacate Biosphere Reserve, Sonora, 7 Mar 2015. (B) Hartwell Canyon, NW of Sedona, Yavapai Co., 4 May 2005, photo by Max Licher (SEINet). (C) Middle fork of Alamo Canyon, 26 Mar 2005.

OP: Quitobaquito: With *Poa annua* and *Myosurus* in marshy area bordering alkaline pool, 18 Mar 1945, *Gould 2987*; Wet soil on edge of lake, 17 Apr 1952, *Parker 7995*. Alamo Canyon, *Dakan 6 May 1973* (ORPI). Bull Pasture, 5 Apr 1978, *Bowers 1207* (ORPI).

CP: Las Playas, *Phelps 19 Mar 1978* (ASU). Jose Juan Represo, 12 Jun 1992, *Felger 92-563*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger* (observation).

PLUMBAGINACEAE – Leadwort Family

Perennial herbs and shrubs; 27 genera, 836 species.

Plumbago

Herbs and shrubs; worldwide, 20 species.

Plumbago zeylanica Linnaeus
[*P. scandens* Linnaeus]
Doctorbush; *estrenina*. Figure 54.

Sprawling subshrub perennials, with upright to scandent stems. Leaves thin, mesophytic, and tardily drought-deciduous, often 6–10+ cm long, petioled, the blades lanceolate to elliptic or ovate. Flowers 5-merous, often 1+ cm wide. Corollas, filaments, style and stigma satiny white, the anthers violet-purple before opening longitudinally to shed the white pollen, the anthers then turn dark blue. The calyx bears stalked glands that stick to almost anything, and similar glands on the flowering stalk and bracts begin exuding at about the time of anthesis, perhaps protecting the flowers and fruits from predation; the calyx encloses the fruit. Fruits of 1-seeded capsules, 8 mm long, circumscissile near the base, readily detaching and adhering. Flowering at various seasons with warm weather and sufficient soil moisture.

Uncommon, in mesic areas of canyons in the Ajo Mountains.

Eastward in southern Arizona to Texas, Florida, and to South America and widespread in the Old World.

OP: N fork of Alamo Canyon, 2750 ft, 7 Oct 1951, *Parker 7744*. Arch Canyon, 3 May 1979, *Bowers 1299*.

Figure 54. *Plumbago zeylanica*. Cultivated plant in Ajo garden: (A & C) 28 Sep 2008; (D) 26 Sep 2006. (B) Barranca de Batopilas, Sierra Madre Occidental, Chihuahua, Mexico, 22 Mar 2007, photo by Patrick Alexander.

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AJO PEAK TO TINAJAS ALTAS: FLORA OF SOUTHWESTERN ARIZONA PART 18. EUDICOTS: POLEMONIACEAE – PHLOX FAMILY

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ABSTRACT

A floristic and natural history account is provided for the phlox family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona. The family includes 9 genera, *Aliciella*, *Eriastrum*, *Gilia*, *Ipomopsis*, *Langloisia*, *Leptosiphon*, *Linanthus*, *Loeseliastrum*, and *Phlox*, and 14 species in the flora area, all of which are native, plus unidentified *Gilia* fossils 8130 to 13,500 ybp. This is the eighteenth contribution for this flora published in Phytoneuron.

This contribution to our flora in southwestern Arizona is published in a series in Phytoneuron and also available open access on the website of the University of Arizona Herbarium (ARIZ): http://cals.arizona.edu/herbarium. The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1). The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). Fossil specimens from packrat middens are indicated with a dagger symbol (†). All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2016). All photos and scans are by Sue Rutman unless otherwise stated. Generic descriptions for the Polemoniaceae cover the genus as a whole, while the keys and species description pertain to populations as they occur in and near the flora area.

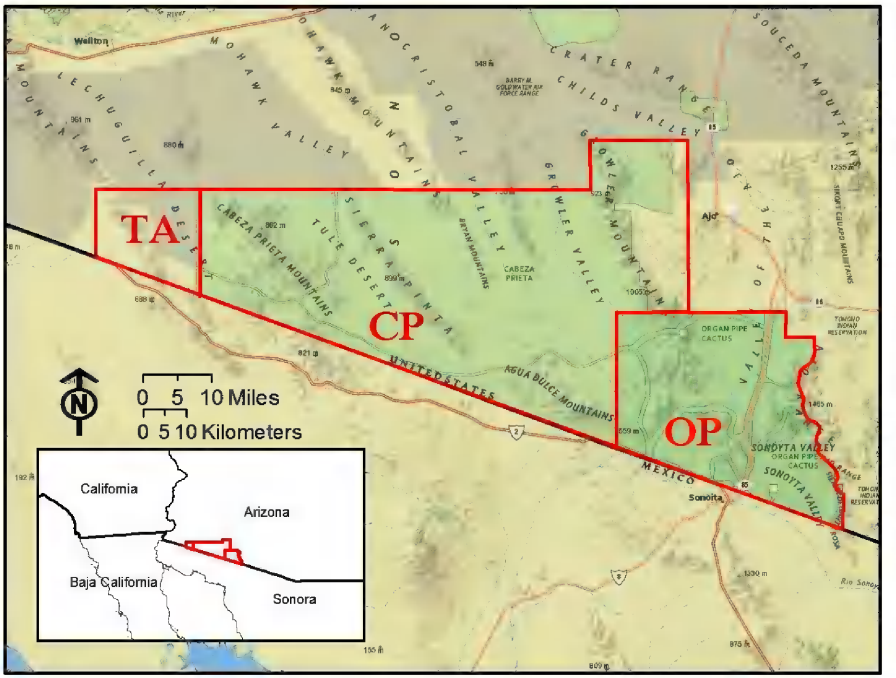

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

POLEMONIACEAE – Phlox Family

Ephemerals or perennial herbs (rarely shrubs, small trees, or vines elsewhere). Leaves opposite or alternate, in basal rosettes, or opposite below and alternate above, simple and entire to dissected; stipules none. Flowers in modified cymes or solitary, 5-merous, radial (actinomorphic) or bilateral (zygomorphic). Sepals usually fused below into a tube. Corollas sympetalous; filaments attached to the tube. Ovary usually 3-carpellate with 3 chambers. Style 1; stigma lobes 1 per carpel (stigmas 3-lobed among those in the flora area). Fruit usually a capsule; seeds 1–many, often mucilaginous. North temperate regions worldwide, western North America, and western South America; 20 genera, 385 species (Porter & Johnson 2000; Porter & Patterson 2015; Wilken & Porter 2005).

Among the 14 species in the flora area, two are perennials (*Ipomopsis multiflora* and *Phlox tenuifolia*) and the others are cool-season ephemerals. There are no summer or non-seasonal ephemerals and no facultative annual/perennials. The two perennials are restricted to the Ajo Mountains, while most of the ephemerals are widely distributed across the flora area although mostly in Organ Pipe. There are no non-native Polemoniaceae in the flora area. *Gilia* fossil specimens were found in fossil packrat middens. Representatives of Polemoniaceae in the flora area show

biogeographic affinity with regions of winter rainfall to the west and north, especially California and the Great Basin. Their seeds are small, not winged, and except for those in *Aliciella*, *Linanthus demissus*, and *Phlox*, are highly hygroscopic and upon contact with water immediately produce an envelope of slime, or mucilage, which as it dries tenaciously cements the seed to anything it touches. These species tend to have relatively thick, wrinkled seed coats that expand when wet.

Table 1. Local distributions and growth forms of Polemoniaceae. † = Fossil. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. WI = winter-spring/cool-season ephemerals and PR = perennials.

Taxa	Region			Growth Form	
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Winter ephemeral	Perennial
Aliciella latifolia		CP	TA	WI	
Eriastrum diffusum	OP	CP	TA	WI	
Eriastrum eremicum	OP			WI	
Gilia flavocincta	OP			WI	
Gilia stellata	OP	CP	TA	WI	
(† *Gilia* sp.)	(OP)			(WI)	
Ipomopsis multiflora	OP				PR
Langloisia setosissima	OP	CP	TA	WI	
Leptosiphon chrysanthus	OP			WI	
Linanthus bigelovii	OP	CP		WI	
Linanthus demissus	OP			WI	
Linanthus jonesii	OP	CP	TA	WI	
Linanthus maricopensis		CP		WI	
Loeseliastrum schottii			TA	WI	
Phlox tenuifolia	OP				PR
Totals: 14	11	6	6	12	2

1. Leaves opposite (upper leaves sometimes alternate); flowers nocturnal or diurnal.

2. Perennials; flowers diurnal and white; Ajo Mountains…… **Phlox**
2. Ephemerals; flowers nocturnal or diurnal, white, yellow, or cream and speckled; widespread.

3. Flowers bright yellow; opening diurnally, closed at night…….... **Leptosiphon**
3. Flowers white or cream and speckled; opening at sunset and nocturnal, generally closed during the day or if diurnal then flowers with red, maroon or purplish spots or streaks in the throat. …….. **Linanthus**

1. Leaves alternate; flowers diurnal.

4. Perennials from a knotty, woody base; stems leafy throughout…….. **Ipomopsis**
4. Spring ephemerals; first leaves in a basal rosette, the stem leaves reduced or clustered near stem tips.

5. Flowers in woolly heads; corolla lobes blue……..... **Eriastrum**
5. Flowers not in woolly heads; corolla lobes various colors, sometimes bluish (among *Gilia*).

6. Leaves and calyx lobes bristle-tipped; flowers sessile in leaf axils or in dense, compact and leafy-bracted heads.

7. Leaves broadest near the tip; most leaves with some 2- or 3-forked bristles; corollas radial or nearly so..... **Langloisia**
7. Leaves linear, not expanded above; leaf bristles all single; corollas bilateral, 2-lipped. ..... **Loeseliastrum**

6. Leaves and calyx lobes not bristle-tipped; flowers mostly pedicelled; inflorescence open, with few and reduced leaves and overtopping the leaves.

8. Leaves more or less ovate, toothed but not dissected, to about 2 times longer than wide; corollas bright reddish pink..... **Aliciella**
8. Leaves pinnately dissected, more than 3 times longer than wide; corolla lobes white to pale lavender-blue or lavender-pink..... **Gilia**

Aliciella

Annuals and perennial herbs. Stems erect, ascending or decumbent, glabrous, pubescent, or glandular. Leaves alternate (basal leaves usually in a rosette), simple and entire, lobed, toothed, or 1- or 2-times pinnately lobed, the apices acute, acuminate, or mucronate; cauline (stem) leaves reduced above and ultimately bract-like. Inflorescences open, cymose, flowers 1–3 per cyme. Calyx glandular and with hyaline membranes alternating with the herbaceous costae and lobes. Corollas longer than the calyx, the corolla lobes usually shorter than the tube, ovate, acute, or acuminate. Fruits spheric to ovoid, with 3 locules, the valves dehiscing from the apex. Seeds 3–many, yellow or brown, not mucilaginous when wet (except sometimes in *A. latifolia*). Western North America; 25 species (Porter 1998).

Aliciella latifolia (S. Watson) J.M. Porter subsp. **latifolia**
[*Gilia latifolia* S. Watson]
Broad-leaf gilia. Figure 2.

Cool-season ephemerals, glandular pubescent and highly variable in size; (2.5) 5–30 cm tall, often branched, occasionally unbranched when drought stressed. Smaller plants with mostly basal leaves, larger plants with moderately leafy stems. Leaves alternate (lower leaves occasionally sub-opposite), (0.7) 1.5–7 × 1.2–3.2 cm, lower leaves petioled, the petioles often winged, the upper leaves often sessile; leaf blades broadly ovate, coarsely toothed to laciniate, the teeth 1–2 mm long. Inflorescences of few- to many-flowered panicle-like cymes; flowers pedicelled. Calyx 4–6 mm long, the segments narrow and sharply pointed, and membranous between the green midribs. Corollas bright reddish pink (magenta internally, pale pink externally). Filaments papillose toward the tip. Dried anthers white. Seeds 0.6–0.7 mm long, yellow-tan, glistening, plump, and more or less ovoid, not (or slightly) mucilaginous when wet.

Slopes and adjacent bajadas and washes in Cabeza Prieta, at least in the vicinity of Tule Well and the Growler Mountains, and in the Tinajas Altas Mountains.

Western Arizona, southeastern California, southern Nevada, southwestern Utah, northeastern Baja California, and northwestern Sonora. A second subspecies occurs in Utah.

CP: Tule Well, *Goodding 6 March 1940* (ASU). Tule Mts, 26 mi W of Papago Well, 15 Apr 1940, *Benson 10795*. 1 km N of Tule Well, 11 Apr 1993, *Felger 93-441A*. 1.3 km NNW of Charlie Bell Pass, 3.5 km W of Daniels Arroyo, E slope of Growler Peak, 22 Apr 1993, *Walter 269* (ASU).
TA: In a pass N of Tinajas Altas Pass, 1200 ft, *Halse 31 Mar 1973*.

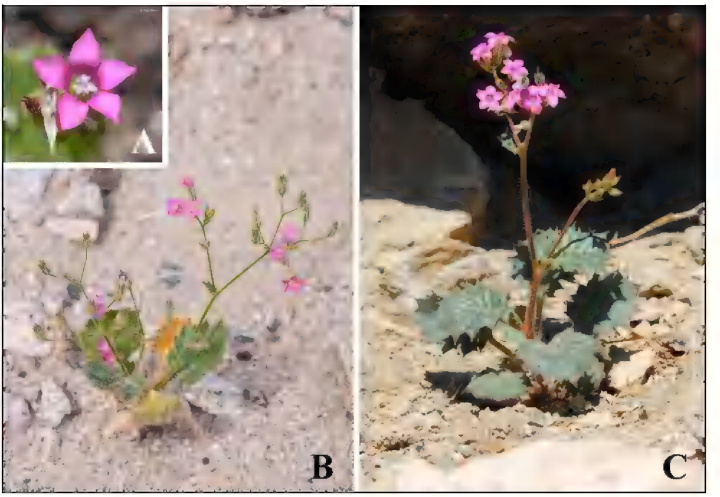

Figure 2. *Aliciella latifolia* subsp. *latifolia*. (A) Kelbaker Lavabeds, Mojave National Preserve, San Bernardino Co., California, 14 Apr 2005, photo by Keir Morse (CalPhotos). (B) Box Canyon, E of Mecca, Riverside Co., California, 6 Apr 2011, photo by Richard Spellenberg. (C) Saline Valley, Inyo Co., California, 17 Apr 2009, photo by Gary A. Monroe (CalPhotos).

Eriastrum

Cool-season ephemerals in southwestern Arizona, also warm-season ephemerals or perennials elsewhere. Stems erect to spreading, glabrous or floccose, occasionally also glandular. Leaves alternate, simple or more often pinnate-lobed, the lobes spinulose-tipped. Inflorescences usually composed of bracteate, woolly, head-like units, the flowers often sessile; bracts leaf-like. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, the lobes unequal in length, sparsely floccose to canescent, apex spinose. Corollas actinomorphic or zygomorphic, funnelform to salverform; stamens equal or unequal, anthers sagittate; style included or exserted. Fruits ovoid, with 3 locules, the valves dehiscing from the apex. Seeds 1–several per locule, mucilaginous when wet. Western North America; 16 species.

1. Corollas 7–8 mm long, the lobes shorter than the tube; stamens attached midway in corolla throat; anthers 0.5–0.8 mm long..... **Eriastrum diffusum**
1. Corollas 10–16 mm long, the lobes as long as to longer than the tube; stamens attached at base of the throat; anthers 1.2–2.2 mm long..... **Eriastrum eremicum**

Eriastrum diffusum (A. Gray) H. Mason
Woolly-star. Figure 3.

Ephemerals; stems erect or spreading, 3–20 cm long, wiry and diffusely branched above (unbranched when drought-stressed), the main axis short, sparingly white-woolly, glabrate in age. Leaves narrowly linear or pinnatifid with 3 or 5 narrowly linear segments, the segments spinulose-tipped; lower leaves largest, 1–4 cm long, usually deciduous at or soon after flowering. Flowers in compact, white-woolly heads, these subtended by leafy bracts 8–17 mm long and similar in form to the leaves. Calyx lobes spinulose. Corollas funnelform, mostly radially symmetric, 6–9 (10) mm long, the tube white or yellowish, the lobes blue, 3–3.5 mm long; corollas falling with daytime heat. Stamens 2–3 mm long, the filaments attached in upper throat, unequal in length and exserted; the

anthers 0.5–0.6 (0.8) mm long. Seeds mucilaginous when wet. The small flowers and small anthers suggest a selfing (autogamous) breeding system. Flowers open during the middle of the day, March and April.

Widespread in many habitats across the flora area including washes, valley bottoms and plains, hills, and mountains.

Southeastern California to western Texas and Utah, Colorado, Baja California, and northern Sonora.

OP: Bates Mts, 8 mi S of Growler Well, *Nichol 17 Apr 1939.* Sinita Basin, 23 Mar 1969, *Lehto 15396* (ASU). Aguajita, wash, 6 Apr 1988, *Felger 88-293.* Armenta Ranch, *Wirt 10 Mar 1991* (ORPI).
CP: Papago Well, 22 Mar 1935, *Kearney 10870.* Las Playas, 15 Apr 1964, *Niles 354.* Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-281.* Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-311.* Growler Wash, 10 Apr 1993, *Felger 93-368.*
TA: NE end of Tinajas Altas Pass, *Van Devender 6 Mar 1983.* Coyote Water, 18 Mar 1998, *Felger* (observation).

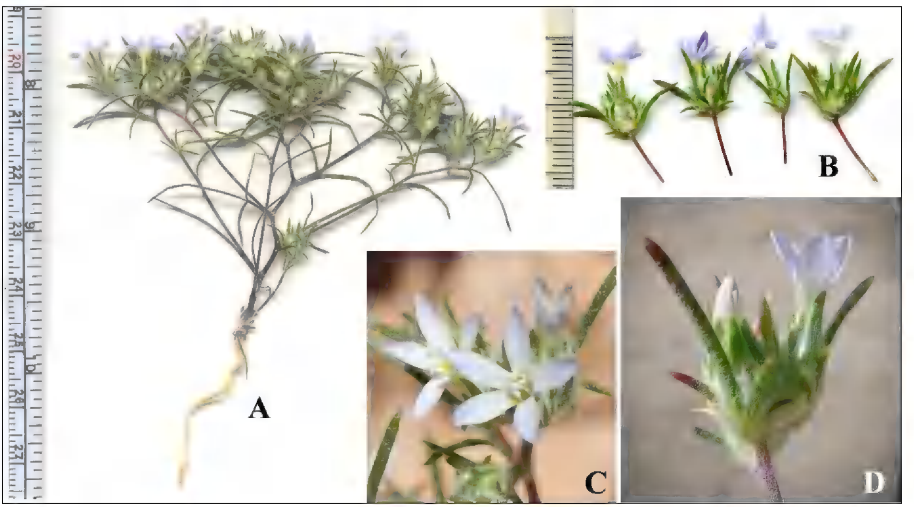

Figure 3. *Eriastrum diffusum.* (A) Kuakatch Wash near Hwy 85, 21 Mar 2008. (B) Midway Wash at Hwy 85, 8 Mar 2015. (C) Bates Well Road, 29 Feb 2008. (D) Anza Borrego State Park, San Diego Co., California, 5 Apr 2013, Keir Morse (CalPhotos).

Eriastrum eremicum (Jepson) H. Mason subsp. **yageri** (M.E. Jones) H. Mason
Desert woolly-star. Figure 4.

Ephemerals; stems openly branched and erect but spreading, 3.5–28 (34) cm long, wiry and diffusely branched above (unbranched when drought-stressed), the main axis short; stems sparsely glandular, floccose or sparingly white-woolly, glabrate in age. Leaves narrowly linear or pinnatifid with 3 to 5 narrowly linear segments, the segments aristate; lower leaves largest, 0.8–3.5 cm long, usually dark reddish brown or tan at or soon after flowering. Inflorescences terminal, capitate, of slightly to densely white-woolly heads, these subtended by leafy bracts 7–22 mm long and similar in form to the leaves. Calyx lobes glandular and spinulose. Corollas funnelform, zygomorphic to nearly

actinomorphic (sometimes shape ± actinomorphic but color pattern zygomorphic), 10–23 mm long; the tube white but mid-tube blue with reddish marks proximally, the throat yellow, white, or pale blue and with yellow patches; the lobes blue to pale blue to white, often with some darker purple or blue streaks or spots near the base, 3–7 mm long. Stamens 3–8 mm long, the filaments attached in the lower throat, unequal in length and long exserted; the anthers 1.2–1.7 (2.2) mm long. Seeds mucilaginous when wet.

In the flora area known from a few specimens from the Ajo and Growler mountains.

This species occurs in western Arizona, mostly above the deserts and at upper elevations within the deserts, to southwestern Utah, southern Nevada, southeastern California, and northeastern Baja California. Subsp. *yageri* occurs in Arizona and Nevada.

CP: Lower slopes of Growler Mts NE of Charlie Bell Pass, tributaries to Daniel's Arroyo, 20 Mar 1992, *Crawford 7a* (ASC, det. H.D. Hammond).

OP: Alamo Canyon, *Tinkham Apr 1942*. Growler Canyon (E of Bates Well), 19 Mar 1975, *Lehto 1823* (ASU).

Figure 4. *Eriastrum eremicum* subsp. *yageri*. (A) Kofa Queen Canyon, Kofa Mountains, Kofa National Wildlife Refuge, Yuma Co., 5 Apr 2014. (B) Near Bull Basin, Upper Verde River, Yavapai Co., 6 May 2013, photo by Frankie Coburn (SEINet). (C) Near Rio Verde Ranch, Yavapai Co., 6 May 2013, photo by Frankie Coburn (SEINet).

Gilia

Annuals (cool-season ephemerals in the flora area) with taproots or herbaceous perennials; glabrous, capitate-glandular, pilose, or floccose (cobwebby). Stems erect, ascending or decumbent (unbranched and highly reduced when drought-stressed). Leaves alternate, basal leaves usually forming a rosette, simple, entire, dentate, pinnately- or bipinnately-lobed; cauline leaves reduced in size. Inflorescences cymose, bracteate panicles. Flowers funnelform, 5-merous, but 3–10-merous flowers are observed. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, glabrous, floccose or glandular. Corollas funnelform, more or less actinomorphic; lobes ovate to lanceolate, obtuse, acute or acuminate. Stamens epipetalous, equally inserted on the corolla at the

sinuses of the lobes or lower, the filaments equal or unequal, included or exserted. Fruits globose, ovoid or obovoid, with 3 locules, dehiscing from the apex one-third of the length of the valve or the valves completely separating. Seeds 3–many, small, ovoid to angular, yellowish to brown, mucilaginous when wet.

Western North America and South America; about 40 species. Only two species have been collected in the flora area; however, another, *Gilia mexicana* A.D. Grant & V.E. Grant, is expected in mesic areas of mountains. It differs in having small flowers (the tube and throat subequal or shorter than the calyx), purplish spots at the base of the corolla lobes, and leaf lobes that are narrowly linear.

1. Lower part of plant with at least some cobweb-like hairs; calyx (2.6) 3–5.5 mm long. ..... **Gilia flavocincta**
1. Hairs bent or crinkled and some are branched (not cobweb-like); calyx 3.5–7 mm long. ..... **Gilia stellata**

Gilia flavocincta A. Nelson subsp. **australis** (A.D. & V.E. Grant) A.G. Day & V.E. Grant
[*G. ophthalmoides* Brand subsp. *australis* (A. Nelson) A.D. & V.E. Grant]
Lesser yellow-throat gilia. Figure 5.

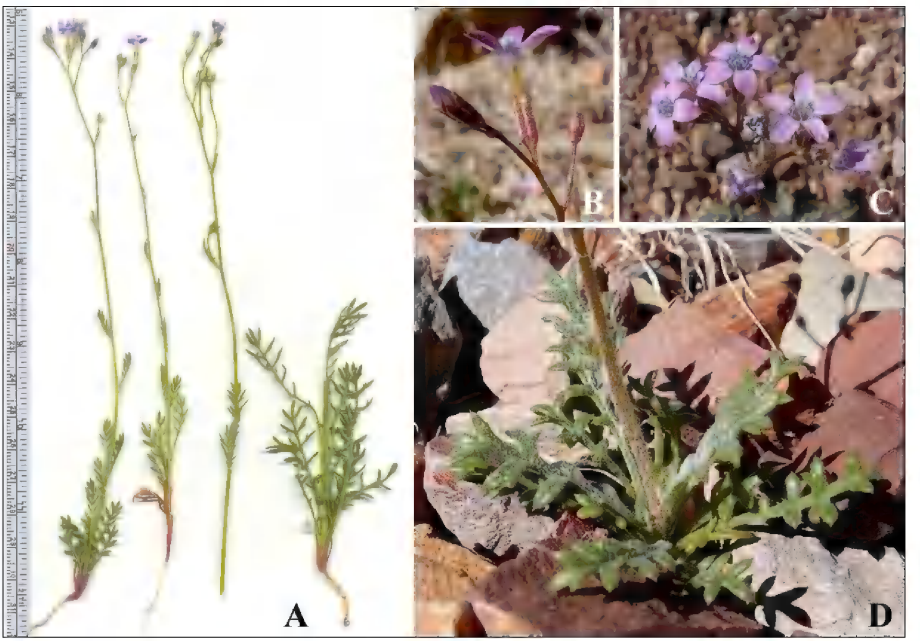

Figure 5. *Gilia flavocincta* subsp. *australis*. (A) Estes Canyon, 2 Mar 2008. (B & D) Salero Ranch, Santa Cruz Co., 28 Feb 2014. (C) State Trust land N of Salero Ranch, 17 Mar 2012. Photos B–D by Sue Carnahan.

Ephemerals; stems 10–30 (45) cm long, spreading, branched throughout, sparsely floccose to woolly below, glabrous and glaucous distally and usually sparsely glandular in inflorescences. Leaves 1.5–8 cm long, forming a loose basal rosette, sparsely cobwebby, pinnatifid or bipinnately-

lobed, the lobes narrow; leaves conspicuously suffused with reddish purple when drought stressed. Inflorescences congested in flower but loose in fruit; generally in 1–2-flowered cymes, the cymes often paired; pedicels unequal, 1.5–14 mm long, usually glandular. Calyx 3–5.5 mm long, glabrous or sparsely floccose; the intercostal membrane and lobes flecked with bright purple or purple-spotted, the lobes acuminate to attenuate. Corollas 7–18 mm long, funnelform, the tube included within and equal to the calyx, the throat exserted, the throat yellow, the lobes 2-6.5 mm long, narrowly to broadly obovate, acute, pink to yellow with violet flecks. Stamens subequal in length, inserted just below the sinuses of the lobes, and slightly exserted. Stigmas adjacent to the anthers. Capsules 5–8.5 mm long, broadly ovoid, widest at base, slightly exceeding or subequal to the calyx; dehiscing ⅓–½ the length of the valve. Seeds 10–35 per capsule, ovoid, angular or reniform, 0.9–1.7 mm long, 0.5–0.9 mm wide, and golden-brown.

Widespread in many habitats across most of Organ Pipe including higher elevations in the Ajo Mountains, but not in the southwestern and the western margins of the monument.

Southern Arizona and Utah to western Texas, Baja California, and northern Sonora. Subspecies *flavocincta*, with larger flowers, occurs in central Arizona.

OP: Valley back of Montezuma's Head, 28 Mar 1941, *McDougall 44.* Sonoyta road 1 mi S of N entrance, 10 Apr 1941, *McDougall 80.* N of Headquarters, 26 Mar 1965, *Ranzoni 298* (ORPI). Mouth of Pitahaya Canyon, 17 Feb 1979, *Bowers 1569* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-275.*

Gilia stellata A. Heller
Star gilia. Figure 6.

Ephemerals; often densely white-villous with geniculate trichomes below. Stems usually several from base, (6) 10–40 cm long, with stipitate-glandular trichomes distally, these usually bearing darkly pigmented terminal glands. Leaves forming a basal rosette, (1) 1.5–8.5 cm long, grayish, pinnatifid or bipinnatifid; the rachis narrow and linear, with toothed lobes, the teeth acute and mucronate; upper cauline leaves greatly reduced, bract-like, entire or 2-toothed. Inflorescences of loose panicles; flowers in 2-flowered cymes, pedicels spreading, unequal in length, glabrous or glandular. Calyx 2.5–5.5 (7) mm long, villous or capitate-glandular; the lobes triangular-attenuate. Corollas 5–8.2 (9) mm long, funnel-shaped, the tube included or slightly exserted, the throat yellow with purple or reddish spots, the lobes pink or white. Stamens diverging from the corolla at the sinuses of the corolla lobes, and slightly exserted. Style slightly exserted. Capsules 5–7 mm long, widely ovoid, subequal or shorter than the fruiting calyx. Seeds 9–18 per capsule; 1.2–1.6 mm long, orange, lumpy, and angular like a miniature orange gumdrop that has been in a backpack too long. As with many other gilias, the flowers are protandrous (stamens dehisce before stigma is receptive), suggesting outcrossing. However, Grant & Grant (1964) include this as an autogamous species of *Gilia*.

Common and widespread across the flora region in many habitats including washes, bajadas, hills, and mountains.

Widespread in Arizona, southeastern California, southern Nevada, southwestern Utah, western New Mexico, Baja California, and northwestern Sonora. If some hairs are crinkled (bent) and some are branched, then it is *G. stellata*.

OP: Alamo Canyon, *Nichol 26 Mar 1939.* Canyon Diablo, 21 Mar 1935, *Kearney 10811.* Alamo Canyon, floor of canyon, streambed, 2000 ft, flowers with yellow throat, blue flare, 19 Apr 1942, *Cooper 743.* Dripping Springs, *Clark 12 Mar 1944* (ORPI). ½ mi NE of Quitobaquito, 18 Mar 1945, *Gould 2993.* Flats W

of Bates Well Mts, 31 Mar 1978, *Bowers 1163.* Arch Canyon, 5 Apr 1978, *Bowers 1185.* Base of Scarface Mt, 1650 ft, *Tallarovic 20 Mar 1992* (ASC).

CP: S end Sierra Pinta, *Monson 20 Mar 1958.* El Camino Diablo, 7.6 mi E of Papago Well, just S of Sheep Mountains at N end of Agua Dulce Mts, granitic hills, 12 Mar 1983, *Daniel 2658* (ASU). Agua Dulce Mts, ½ mi N of Papago Well, 16 Mar 1992, *Yeatts 3204* (CAB). Charlie Bell Pass, white blossoms, somewhat rank smelling, 3 Apr 1992, *Whipple 3915.* Tule Tank, 14 Apr 1992, *Harlan 287.* Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-285.*

TA: Tinajas Altas Pass, 20 Feb 1979, *McLaughlin 1972.* Vicinity of Tinajas Altas, 1200 ft, flowers light purple, 32º18'40'114º03'08"W, Va*n Devender 5 Mar 1983.* Coyote Water, 25 Oct 2004, *Felger* (observation).

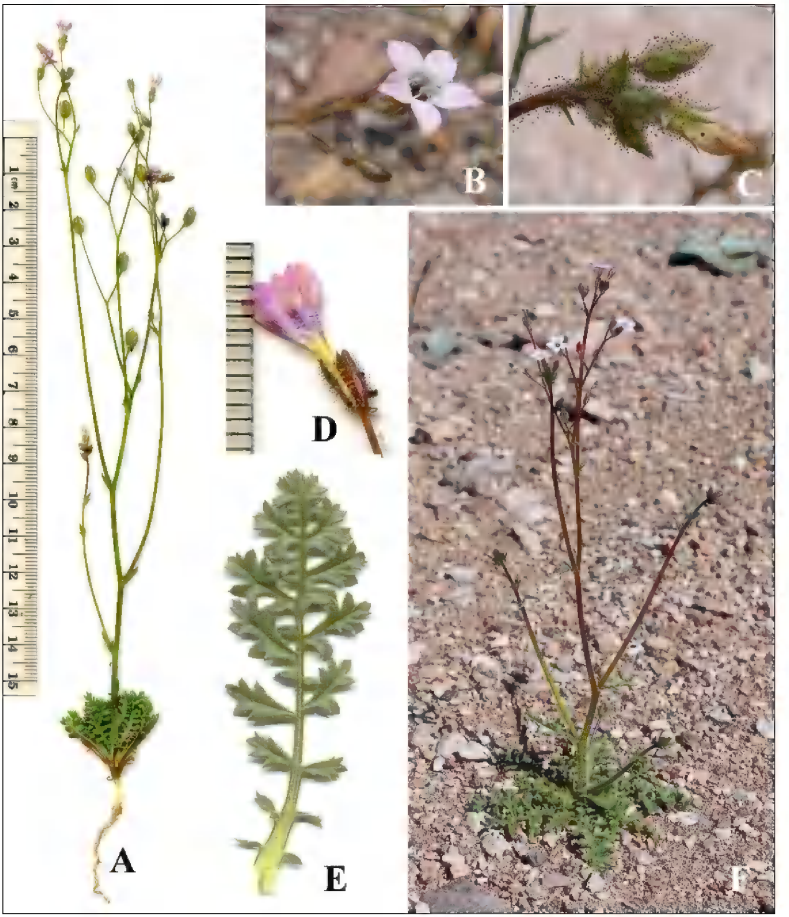

Figure 6. *Cilia stellata.* (A) Senita Basin, 16 Mar 2015. (B) Near Ragged Top, Ironwood Forest National Monument, Pima Co., 25 Mar 2012, photo by Sue Carnahan. (C) Flats E of Tinajas Altas, 2 Mar 2014, photo by Sue Carnahan. (D) Sierra de Águila near Mex Hwy 2, Sonora, 7 Mar 2015. (E) Estes Canyon, 8 Feb 2003. (F) Alamo Wash, 5 Mar 2014.

Gilia sp.

OP: †Alamo Canyon, capsules, 8130 to 9570 ybp (3 samples). Montezuma's Head, capsules, 13,500 ybp.

Ipomopsis

Annuals (cool-season ephemerals), perennial herbs, or subshrubs, simple or branched. Leaves basal or alternate, entire to deeply pinnately lobed, gradually reduced upward, the lobes confluent with the rachis, flat or terete, usually linear. Inflorescences terminal, paniculate, open or congested, the basic unit composed of 2–7 pedicelled flowers subtended by a single bract, these sometimes thyrsoid and arranged along one side of the rachis. Flowers actinomorphic or zygomorphic. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, glabrous, villous or glandular, the tube membranes usually ruptured in fruit. Corolla usually salverform, white to purplish or red; stamens unequally inserted on the corolla tube or throat; filaments equal or unequal in length; anthers included or exserted; style included to exserted. Capsule ovoid; seeds 1–many per locule, becoming mucilaginous when wet. North and South America; 30 species.

Figure 7. *Ipomopsis multiflora*. (A & B) Arch Canyon, above the arch, 16 Sep 2006. (C) Above Bull Pasture, 21 Sep 2008.

Ipomopsis multiflora (Nuttall) V.E. Grant
[*Gilia multiflora* Nuttall]
Many-flowered gilia. Figure 7.

Short-lived perennials with a somewhat woody base (subshrub). Stems 15–45 (50) cm long, simple or branched at base, with white, glandular and non-glandular hairs. Leaves 0.6–3.5 cm long, pinnately lobed with 3–7 (9) linear lobes, 2–10.3 mm long; the upper cauline leaves usually simple; glabrous or sparsely short pilose or glandular. Inflorescences terminal, one-sided panicles, with

flowers subsessile and crowded on short, lateral branches. Flowers showy, zygomorphic. Calyx 3.5–8 mm long, glandular pubescent, often also with non-glandular trichomes; the lobes short-aristate. Corollas pale violet to purplish or bright lavender with white and darker purple markings forming a nectar guide; the tube 5–15 mm long (usually 10 mm or more); the lobes narrowly ovate, (3) 4–6 mm long. Filaments and style bright lavender, the stamens inserted on the upper tube or throat, long exserted but unequal in length, the anthers blue. Capsules 4.5–7 mm long, (3) 5–24-seeded.

Higher elevations in the Ajo Mountains; often rooted in rock crevices on bedrock and pockets of shallow soil.

Mainly in Arizona and New Mexico but not in the desert, and also northeastern Sonora (*Walker 25 Aug 1966,* UCR) and expected in northern Chihuahua.

OP: Arch Canyon, 3200 ft, 12 Oct 1988, *Baker 7641* (ASU). Boulder Canyon, 3200 ft, 13 Oct 1988, *Baker 7645* (ORPI). Route to saddle between Boulder and Arch Canyons, *Rutman 27 Sept 1998* (ORPI). Above Bull Pasture on trail to Mt Ajo, *Rutman 10 Apr 2005.*

Langloisia

Annuals, compact and much branched, the branches rigidly spreading to ascending. Leaves alternate, subsessile, lanceolate or oblanceolate, coarsely toothed or pinnately lobed, the teeth and lobes with 1–3 bristles. Inflorescences terminal, sub-capitate, and bracteate, the bracts leaf-like but reduced in size. Flowers actinomorphic, subsessile. Calyx with hyaline membranes alternating with the herbaceous costae and lobes; the membranes rupturing in fruit; the lobes bristle-tipped. Corolla funnelform. Stamens equally inserted on the upper tube; filaments equal in length and straight; anthers mostly exserted. Stigmas exserted. Capsule ellipsoid, triangular in cross-section, dehiscent, the 3 valves separating completely with age. Seeds 6–30, becoming mucilaginous when wet. A genus of one species closely allied to *Loeseliastrum.*

Langloisia setosissima (Torrey & A. Gray) Greene subsp. **setosissima**
Great Basin langloisia. Figure 8.

Cool-season ephemerals, compact and bristly, (2) 3–10 cm tall, often much-branched, the main axis very short or lacking, stems leafy throughout, pubescent with branched trichomes. Leaves alternate, narrowly obovate or oblanceolate, the larger ones 1–2.5 cm long, toothed or pinnately lobed, the segments triangular and prominently bristle-tipped; bristles white, (3) 5–9 mm long, 2- or 3-forked on lower lobes of all except the first leaves. Calyx segments bristle-tipped. Corollas 10–16 mm long, radial or nearly so, lavender-pink and showy. Anthers and pollen white to blue. Capsules 5–7 mm long, the valves separating at maturity. Seeds 3–9 per locule, 1.1–2 mm long, ellipsoid to short and squat depending on position in capsule, pale orange-yellow, mucilaginous when wet. Often flowering in March, plants dying by mid-April.

Occasional in the western part of Organ Pipe and widespread in Cabeza Prieta and Tinajas Altas; sandy to rocky habitats, washes, plains and bajadas, hills, and mountains, generally on granitic, limestone and other calcium-rich substrates.

Also in the Pinacate volcanic region of northwestern Sonora, western Arizona, southeastern California, southern Nevada, and southwestern Utah. Subspecies *setosissima* is replaced by subsp. *punctata* (Coville) Timbrook to the north and northwest in southern California, Nevada, Idaho, and eastern Oregon.

OP: 4 mi N of Bonito Well, 9 Apr 1941, *McDougall 60.* 10 mi N of Bates Well Road & Puerto Blanco Drive, 30 Mar 1978, *Bowers 1119.*

CP: Tule Well, *Goodding 6 Mar 1940* (ASU). Buckhorn Tank (Simmons 1966). Cabeza Prieta Tank, canyon, 6 Apr 1979, *Lehto 23541* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3941*. 1 km N of Tule Well, 11 Apr 1993, *Felger 93-443*. Chico Shuni Wash, 2 Feb 2003, *Rutman 2003-34*.

TA: E side Tinajas Altas Pass, 18 Mar 1998, *Felger 98-102*.

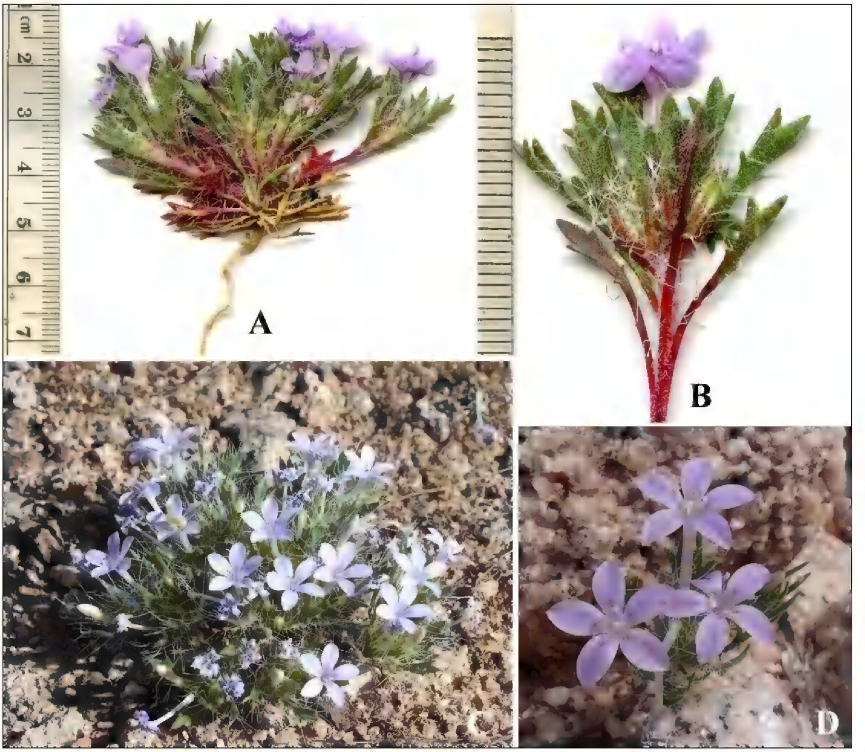

Figure 8. *Langloisia setosissima* subsp. *setosissima*. (A & B) Sierra de Águila near Mex Hwy 2, Sonora, 7 Mar 2015. (C) Lookout Mountain, N of Ajo, Maricopa Co., 12 Mar 2014. (D) Flats E of Tinajas Altas, 2 Mar 2014, by Sue Carnahan.

Leptosiphon

Annuals or perennial herbs; stems erect to decumbent, usually branched from base, occasionally simple, and leafy. Leaves opposite, rarely alternate above, entire or with 3–9 palmately arranged lobes, the lobes confluent with the rachis, linear, flat to terete, acute to weakly spinulose. Inflorescences terminal and head-like or axillary few-flowered cymes, or solitary; glabrous, pubescent or glandular. Flowers pedicelled, actinomorphic. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, sometimes the membranes quite narrow and usually ruptured or distended in fruit, the lobes equal, linear to attenuate, and often mucronate. Corollas funnelform, salverform or campanulate, with a hairy ring inside the tube or the ring absent. Stamens equally inserted on the corolla throat or tube; anthers slightly exserted or included; filaments equal in length. Style included to exserted. Capsules ovoid to oblong; seeds 1-several per locule. Western North America and Chile; 30 species.

"*Linanthus* in the traditional sense (e.g., Grant 1959; Patterson 1993) is not monophyletic. In their revised classification of Polemoniaceae, Porter and Johnson (2000) divided *Linanthus* into two genera, resurrecting and expanding *Leptosiphon* Benth., in addition to *Linanthus*" (Porter & Patterson 2015: 57). Due to convoluted complications of nomenclature, the transfer of *Linanthus aureus* into *Leptosiphon* necessitated a new name for that species (Porter & Patterson 2015).

Leptosiphon chrysanthus J.M. Porter & R. Patterson subsp. **chrysanthus**
[*Gilia aurea* Nuttall. *Linanthus aureus* (Nuttall) Greene. *Leptosiphon aureus* (Nuttall) J.M. Porter & L.A. Johnson subsp. *aureus*]
Golden desert-trumpets. Figure 9.

Winter-spring ephemerals. Stems 3–15 cm long, wire-like, the plants usually taller than broad, ascending, glabrous, pilose, or glandular. Leaves opposite, 3–8 mm long, linear or with 3–5 linear lobes, glabrous or glandular. Inflorescences open, the flowers in 1–3-flowered cymes, mostly terminal (the cymes terminate the branches). Flowers on thread-like pedicels, 4–13 mm long, showy and often obscuring the rest of the plant; opening diurnally, closed at night. Calyx glandular, 3–8 mm long, the lobes equaling the tube, the hyaline membranes as wide as the herbaceous costae. Corollas actinomorphic, 6–15 mm long, bright, golden yellow, the tube 6–10 mm long, with 5 broad lobes each 5–7 mm long, and a brighter yellow or maroon center (throat) with a ring of hairs between the tube and throat. Stamens inserted on the throat, pollen orange. Styles slightly exserted. Capsules 2.5–5 mm long. Seeds 1 to many per locule, becoming mucilaginous when wet.

Figure 9. *Leptosiphon chrysanthus* subsp. *chrysanthus*. (A) Tent Rocks, SE of Camp Verde, Yavapai Co., 4 Apr 2007, photo by Max Licher. (B & C) Salero Headquarters, Salero Ranch, Santa Cruz Co., 26 Mar 2014, photo by Sue Carnahan.

Known from Organ Pipe by two records in 1941 from the northern part of the Monument. It is common much farther eastward and northward in Arizona.

Southeastern California to southwestern New Mexico, southwestern Utah, southern Nevada, Baja California, and northern Sonora. A white-flowered form in California deserts is named subsp. *decorus* (A. Gray) J.M. Porter & R. Patterson.

OP: Road to Walls Well, 26 Mar 1941, *McDougall 39.* Flats, N border of Monument, 10 Apr 1941, *McDougall 81* (ORPI).

Linanthus

Annuals or perennials; stems simple or branched from the base, erect to decumbent, and leafy. Leaves mostly opposite, sometimes alternate above, simple, pinnatifid, or deeply palmately lobed, the lobes confluent with the rachis, linear, flat or terete, and acute to mucronate. Inflorescence terminal and open, solitary, in cymes, or densely compact, and glabrous or glandular; subtending bracts identical to the leaves. Flowers sessile or short pedicelled, and actinomorphic. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, usually ruptured or distended in fruit, the lobes equal or unequal, linear to attenuate, and often mucronate. Corollas funnelform, salverform, or campanulate, white, yellow, lavender, or sometimes bluish. Stamens equally inserted on the corolla throat or tube; anthers exserted or included; filaments equal in length. Style included to exserted. Capsules ovoid to oblong; seeds 1–several per locule, mucilaginous or unchanged when wet.

Western North America; 24 species.

1. Leaves with 3 linear lobes; flowers diurnal, in compact clusters, the corollas cream colored and speckled with reddish markings in the throat..... **Linanthus demissus**
1. Leaves mostly linear, simple, or simple below and 3-lobed at the first flowering node; flowers nocturnal, not in compact clusters, the corollas white with dark purple inside the tube.

2. Corollas 8–16 mm long; leaves associated with the terminal flower of the main axis mostly trifid. ..... **Linanthus bigelovii**
2. Corollas (8.5) 12–20 (25) mm long; leaves associated with the terminal flower of the main axis, simple and linear.

3. Flowers small, corollas 8.5–16.5 mm long, the lobes 3.5–7.5 mm long, 2.4–4.8 mm wide; calyx and pedicels with coarse stipitate glands, the stalks multiseriate at base and the terminal gland disc-like and multicellular..... **Linanthus jonesii**
3. Flowers large, corollas 14–30 mm long, the lobes 7.9–20.6 mm long, 5.4–10.2 mm wide; calyx and pedicels with delicate stipitate glands, a few stalks multiseriate at base, others uniseriate and the terminal gland disc-like and multicellular, or the terminal gland globose and bi-cellular. ..... **Linanthus maricopensis**

Linanthus bigelovii (A. Gray) Greene subsp. **bigelovii**
Bigelow desert-trumpets. Figure 10.

Cool-season ephemerals, erect, simple or more often freely and dichotomously branched, (5) 10–25 cm tall. Stems sparsely stipitate-glandular, particularly at the nodes and in the inflorescence (glandular trichomes delicate, with uniseriate stalks and few-celled terminal glands). Leaves 1.5–4.3 cm long, opposite, simple and linear or linear-filiform, commonly the more distal leaves 3-cleft essentially to the base into linear-filiform segments. Inflorescence cymose, diffuse and branching, the terminal flower subsessile or pedicellate, the pedicel 0.2–4 mm long, usually stipitate glandular, commonly closely subtended by a pair of leafy bracts. Flowers vespertine (nocturnal), closed during the day, opening in the late afternoon or evening and remaining open through the night; powerfully fragrant. Calyx 8–14 mm long, the lobes unequal, sparsely to moderately villous, sometimes also

glandular. Corollas actinomorphic, 8–16.3 (20) mm long, the lobes (2) 4–7.5 (14.1) mm long, 1.5–5.9 mm wide, white and generally flecked with purple, maroon, or brown-red on the abaxial lobe margins, and with a band of purple in the upper tube or throat. Stamens inserted in the mid-tube, filaments slender and glabrous; pollen yellow. Capsules cylindroid, 5–10 mm long. Seeds 12–21 per locule, 0.6–1.3 mm long, ellipsoid, angular and reniform; mucilaginous when wet.

Widespread across the flora area including sand flats, dunes, washes, plains, hills, and mountains.

Southeastern California to southwestern Utah and western Texas, Baja California, and northern Sonora. Subspecies *johnsonii* J.M. Porter and R. Patterson, a glabrous and glaucous race, occurs in Arizona, California, and Nevada to the north and west of subsp. *bigelovii*. See discussion for *L. jonesii*.

OP: 0.5 mi N of Quitobaquito, 18 Mar 1945, *Gould 2994*. Bajada, N of Headquarters, *Ranzoni 26 Mar 1965* (ORPI). Ajo Mts, 1 mi NE of picnic area at base of Tillotson Peak, 10 Mar 1973, *Shervanck 702* (RSA). Bull Pasture Trail, 11 Apr 1978, *Bowers 1228*.

CP: 8 mi E of Papago Well, 14 Apr 1941, *Benson 10762A* (RSA). Pinta Sands, 1 Feb 1992, *Felger 92-39*. 0.5 mi N of Papago Well, 16 Mar 1992, *Yeatts 3207* (CAB). Charlie Bell Pass, 3 Apr 1992, *Whipple 3925*. Childs Mt, 9 Apr 1993, *Felger 93-297*. Chico Shunie Wash, ½ mi W of Chico Shunie Well, sand-gravel bed, 1780 ft, 2 Feb 2003, *Rutman 2003-33*.

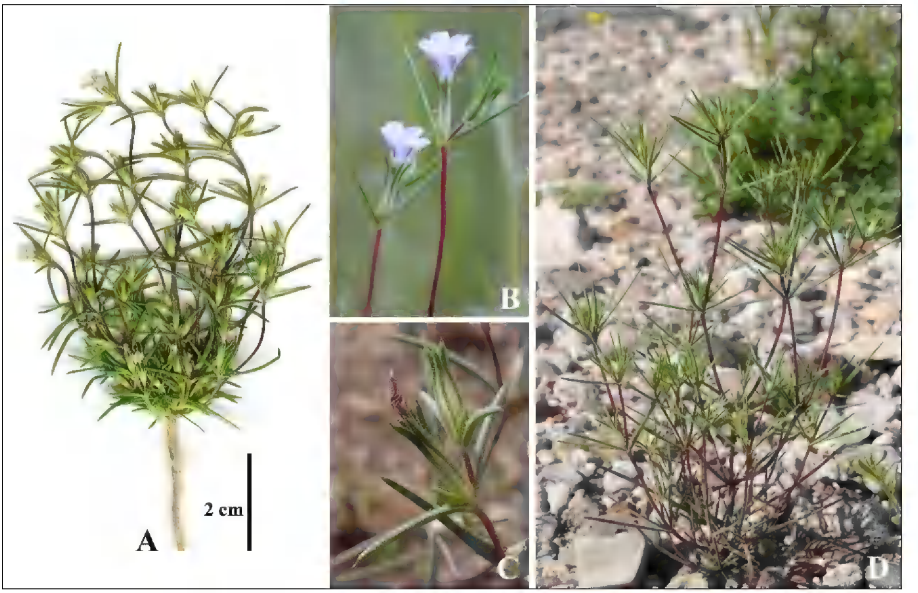

Figure 10. *Linanthus bigelovii* subsp. *bigelovii*. (A) Sierra Los Tanques near Mex Hwy 8, Sonora, 27 Mar 2010. (B) Ajo, 3 Mar 2005. (C) Near Ragged Top, Ironwood Forest National Monument, Pima Co., 25 Mar 2012, photo by Sue Carnahan. (D) Coffeepot Mountain, Sikort Chuapo Mts, Maricopa Co., 27 Feb 2005.

Linanthus demissus (A. Gray) Greene
Desert snow. Figure 11.

Diminutive, cool-season ephemerals, 2–10 cm tall, highly branched throughout; stems ascending or decumbent, glandular and short pilose. Leaves 5–11 mm long, opposite, palmatifid, (leaves rarely simple and linear), the lobes 3 (5), linear, mucronate, glabrous or short-pubescent. Inflorescences solitary in the axils of bracts or in compact, terminal, bracteate clusters. Flowers subsessile, diurnal (open during the day)—the showy flowers may blot out the view of the rest of the plant. Calyx 4–7 mm long, glandular, campanulate, the lobes free to near the base and unequal. Corollas 5–8 mm long, campanulate, white to cream, the lobes white with red or purple flecks or streaks at the base. Stamens inserted near the base of the tube, the filaments glabrous. Style exserted slightly beyond the stamens. Capsules 2.2–3.1 mm long, ellipsoid, dehiscing the full length of the valves. Seeds (4) 5–10 per locule, 0.6–0.8 mm long, not becoming mucilaginous when wet.

Mostly in Arizona Upland regions of Organ Pipe including the Ajo, Bates, Diablo, and Growler mountains, and often localized.

Western Arizona, southeastern California, southern Nevada, and southern Utah.

OP: Wash near Sonoyta Rd, 10 Apr 1941, *McDougall 68.* Rocky slopes S of Bates Well, 18 Mar 1944, *Clark 11407* (ORPI). Low hill, 0.5 mi N of Canyon Diablo on Ajo Mt Drive, 5 Apr 1978, *Bowers 1189* (ORPI). Also see Figure 11A & D.

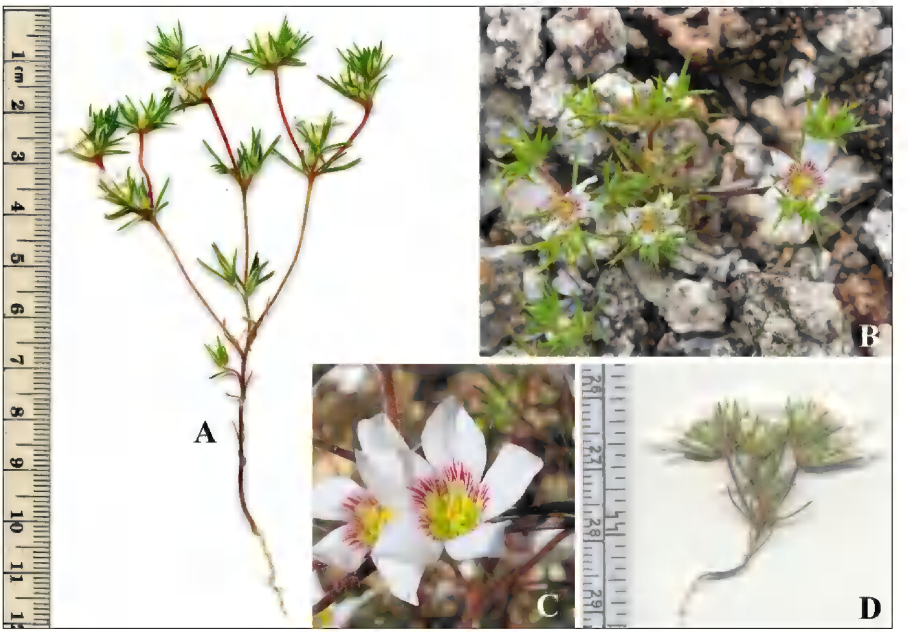

Figure 11. *Linanthus demissus.* (A) Middle elevation hills near N end of Ajo Mountain Drive, Diablo Mts, 22 Mar 2015. (B) On grus, Sand Tank Mountains, W of Javelina Mountain, Maricopa Co., 5 Mar 2005. (C) North Mountain Preserve, Phoenix, Maricopa Co., 23 Mar 2013, photo by Frankie Coburn (SEINet). (D) On grus, near Bluebird Mine, 9 Mar 2014.

Linanthus jonesii (A. Gray) Greene
[*L. bigelovii* var. *jonesii* (A. Gray) Jepson & H. Mason]
Jones's desert-trumpets. Figure 12.

Cool-season ephemerals, erect, simple or more often freely, dichotomously branched, (2.8–) 5–26 cm tall; stems sparsely but coarsely stipitate-glandular throughout, more densely stipitate-glandular at and just below the nodes and in the inflorescence (some of the glandular trichomes robust, with multiseriate stalks and multicellular, disc-like, terminal glands). Leaves 2.1–3 cm long, opposite, simple and linear or linear-filiform, coarsely stipitate-glandular on the upper surface near the nodes. Inflorescence cymose, diffuse and branching, more or less regularly dichotomous, the terminal flower subsessile or pedicellate, the pedicel 0.5–8.2 mm long, coarsely stipitate-glandular; flowers closely subtended by a pair of leafy bracts. Flowers vespertine (nocturnal), closed during the day, opening in the late afternoon or evening and remaining open through the night. Calyx 8–11 mm long, lobes unequal and glandular. Corolla actinomorphic, 8.5–16.5 mm long, the lobes 3.5–7.5 mm long, 2.4–4.8 mm wide, cream to white, generally flecked with purple, maroon or brown-red on the abaxial lobe margin, with a band of purple in the upper tube or throat. Stamen inserted in the mid-tube, filaments slender, glabrous; pollen yellow. Capsules cylindroid, 4–6.3 mm long. Seeds 12–21 per locule, 0.6–0.9 mm long, angular reniform, mucilaginous when wet.

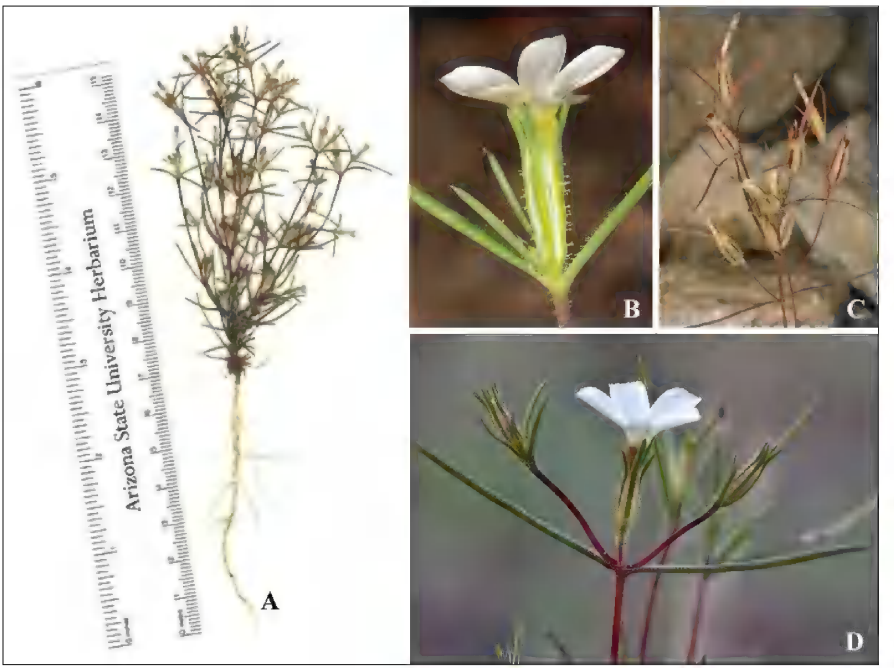

Figure 12. *Linanthus jonesii*. (A) 4.1 mi to Alamo Crossing from junction of Route 60 at Wenden, Yuma Co., 10 Mar 1973, *D.J. Pinkava 10311C* (ASU 49948). (B) Eastern Mojave Desert, Turtle Mts, San Bernardino Co., California, 19 Mar 2010, photo © by Steve Matson (CalPhotos). (C) Owens Valley, W edge of Big Pine near School Street and Big Pine Creek, Inyo Co., California, 26 Apr 2009, photo © by Steve Matson (CalPhotos). (D) Turtle Mts, San Bernardino Co., California, 19 Mar 2010, photo by John Game (SEINet).

Widespread in the Lower Colorado Valley region of the flora area: southwestern Organ Pipe, Cabeza Prieta, and Tinajas Altas.

SE California to southern Nevada, Arizona, Baja California Peninsula, and western Sonora.

Linanthus jonesii can be difficult to distinguish from *L. bigelovii* in southwestern Arizona, suggesting either introgression or a strong genetic link between the two. Distinguishing *L. jonesii* and *L. maricopensis* also can be difficult. This group certainly needs more study. *Linanthus jonesii*, with its coarsely glandular pedicels and calyx, is easily distinguished from *L. bigelovii* in California, but the distinction is less clear in Arizona, where *L. bigelovii* tends to also have glandular trichomes. The glandular trichomes of *L. bigelovii* are relatively delicate and uniseriate (cells in one row) with globular terminal glands. In contrast, *L. jonesii* has coarse, multiseriate (cells in 2 or more rows) glandular trichomes with flattened, tack-like, comparatively large and multicellular terminal glands. (Porter & Patterson 2015).

OP: 0.5 mi N of Quitobaquito, 18 Mar 1945, *Gould 2994.*
CP: 8 mi E of Papago Well, 14 Apr 1941, *Benson 10762A* (RSA). Lower slopes of Growler Mts NE of Charlie Bell Pass, tributaries to Daniel's Arroyo, 1200 ft, 20 Mar 1992, *Crawford 7b* (ASC, det. Felger, Feb. 2012).
TA: Tinajas Altas Mts, *Van Devender 26 March 1983* (det. J.M. Porter, 2012; cited in Felger et al. 2012).

Linanthus maricopensis J.M. Porter & R. Patterson
Maricopa desert-trumpets. Figure 13.

Cool-season ephemerals, 6–25 cm tall, erect, simple (unbranched) or more often freely and dichotomously branched. Stems sparsely but coarsely stipitate-glandular throughout, and more densely stipitate-glandular at and just below the nodes and in the inflorescence (some of the glandular trichomes are robust, with multiseriate stalks and multicellular, disc-like, terminal glands). Leaves 0.8–3.3 cm long, opposite, simple and linear or linear-filiform (rarely 3-lobed with the central lobe longest), coarsely stipitate-glandular on the upper surfaces near the nodes. Inflorescence cymose, diffuse and branching, the terminal flower subsessile or pedicellate, the pedicel 1.5–13.5 mm long, and coarsely stipitate-glandular; flowers closely subtended by a pair of leafy bracts. Flowers vespertine (nocturnal), closed during the day, opening in the late afternoon or evening and remaining open through the night, and very fragrant. Calyx 8–13 mm long, the lobes unequal and glandular. Corollas actinomorphic, 14–30 mm long, the lobes 7.9–20.6 mm long, 5.4–10.2 mm wide, cream to white, generally flecked with purple, maroon or brown-red on the abaxial lobe margins, and with a band of purple in the upper tube or throat. Stamen inserted in the middle of the tube, the filaments slender and glabrous; pollen yellow. Capsules cylindroid, 4.5–9.1 mm long. Seeds 18–32 per locule, 0.6–1.1 mm long, angular and reniform; mucilaginous when wet.

Documented in the flora area from Cabeza Prieta on sandy soils including dunes of the Pinta Sands and nearby areas of blowing sands, and expected elsewhere. In nearby regions also on granitic soils including rocky substrates.

Endemic to Arizona in Maricopa and Pima counties.

This large-flowered species has consistently been identified as *L. dichotomous*. However, it lacks the inflated, villous filament bases and white, pithy seed coats characteristic of *L. dichotomous*. Rather, *L. maricopensis* possesses a number of traits similar to *L. jonesii* (see discussion for *L. jonesii*). Clearly, more research is needed to understand the relationships among these species.

CP: Sand dunes (Pinta Sands) S of El Camino Diablo, 14.4 mi E of Tule Well, 800 ft, with *Oenothera, Larrea, Hesperocallis, Triteleiopsis*, & *Geraea*, 13 Mar 1983, *Daniel 269* (ASU, ver. by Walter Fertig and Felger, 28 Mar 2015). 3½ mi W of Papago Well along Camino del Diablo, sandy soil, with *Oenothera deltoidea* var. *arizonica*, uncommon, 13 Mar 1983, *Mason & Eiber 3601*. E side of Pinta Sands, low dunes encroaching lava field, 32º05'56"N, 113º18'45"W, 240 m, collected and pressed at dusk, flowers sweet-fragrant, corollas white (7 a.m. next morning the flowers were closed), 11 Apr 1993, *Felger 93-427*.

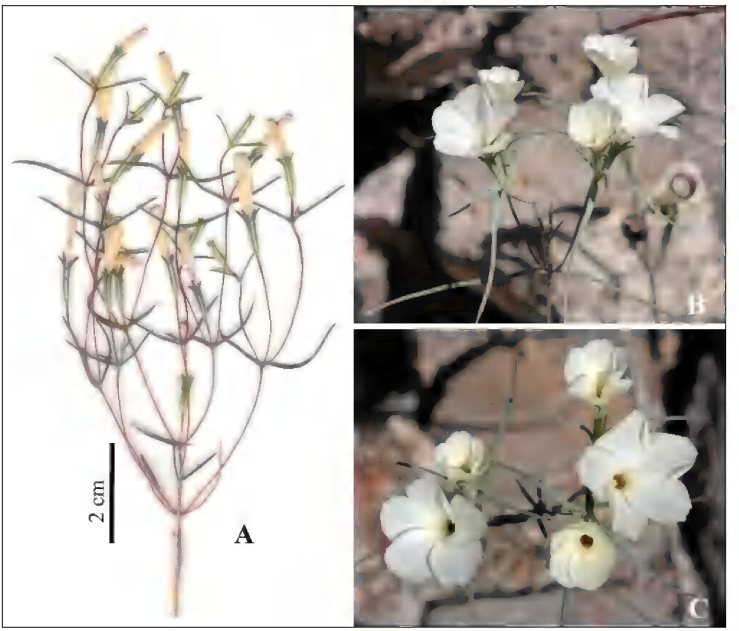

Figure 13. *Linanthus maricopensis*. (A) Sierra Los Tanques near Mex Hwy 8, Sonora, 27 Feb 2010. (B & C) Sand Tank Mts, Maricopa Co., 8 Mar 2008, photos by Patrick Alexander (SEINet).

Loeseliastrum

Annuals, compact and highly branched, the branches rigidly spreading or ascending. Leaves alternate, subsessile, linear to oblanceolate, coarsely toothed or pinnately lobed, the teeth and lobes with 1 terminal bristle. Inflorescences terminal, head-like or sub-capitate, bracteate, the bracts leaf-like but reduced in size. Flowers weakly to moderately zygomorphic, and subsessile. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, the membranes rupturing in fruit, the lobes bristle-tipped. Corollas bilabiate. Stamens subequally inserted on the upper tube; filaments unequal in length, up-curved; anthers mostly exserted. Style exserted. Capsule ovoid, with 3 rounded lobes in cross-section, dehiscent, the 3 valves separating completely with age. Seeds 2–10 per locule, mucilaginous when wet. Western USA and northern Mexico; 3 species.

Loeseliastrum schottii (Torrey) Timbrook
[*Langloisia schottii* (Torrey) Greene]
Schott's calico. Figure 14.

Cool-season ephemerals. Stems 3–12 cm long, leafy distally, sparsely so below; the main axis short, giving the plant a compact but spreading habit; villous-hirsute or villous-puberulent with

crisped, multicellular trichomes. Leaves alternate, 1–3 cm long, broadly linear or narrowly oblong, toothed or shallowly lobed, the teeth and lobes with a bristle 1.5–3.5 mm long, proximal margins of the leaf often densely bristly-ciliate. Flowers white to pink and showy in dense leafy-bracted clusters. Calyx 4–6 mm long, the lobes pilose, glandular, and bristle-tipped. Corollas 8–15 mm long, bilabiate, the tube 4–10 mm long, the upper lip with 3 (4) lobes, 3–7 mm long, the lower lip with (1) 2 lobes, the lobes white to pink, with maroon streaks at the base of the upper lobes. Stamens unequal in length, curving upward, and shorter than the corolla lobes; anthers included to exserted, pollen yellow. Capsules 2–5 mm long, the valves separating at maturity. Seeds 2–6 per locule, ca. 1 mm long, mucilaginous when wet.

Low dunes on the west side of Tinajas Altas Mountains and perhaps elsewhere in the western part of the flora area; common on the Mohawk Dunes (north of the flora area).

Desert and semi-desert in western Arizona, southern California, southern Nevada, southwestern Utah, Baja California, and northwestern Sonora.

TA: Butler Mountains, *Van Devender 27 Mar 1983.*

Figure 14. *Loeseliastrum schottii.* Anza Borrego State Park, San Diego Co., California, 27 Mar 2011, photos by Keir Morse.

Phlox

Herbaceous perennials, often cespitose (but not in the flora). Stems erect to decumbent, often much branched. Leaves mostly opposite, often alternate only in the inflorescence, simple, entire, linear to elliptic or lanceolate. Inflorescences terminal, the flowers in 1–3-flowered cymes. Flowers pedicelled or sessile. Calyx with hyaline membranes alternating with the herbaceous costae and lobes, the membranes ruptured in fruit, the lobes equal. Corollas salverform or occasionally narrowly funnelform, white, pink, red, blue, or purple. Stamens unequally inserted on the tube; filaments short, usually equal in length, and glabrous; anthers and style usually included. Capsule ovoid to ellipsoid. Seeds 1 (2 or 3) per locule, usually not mucilaginous when wet. North America and Siberia; 60 species.

Phlox tenuifolia E.E. Nelson
Mountain phlox. Figure 15.

Perennials, herbaceous or suffrutescent. Stems 1–6 and wiry, 27–82 (125) cm tall, the internodes elongate, pilose to short villous. Leaves linear to narrowly lanceolate, flat, 20–50 mm long, 1–3 mm wide, glabrous or sparsely pilose. Inflorescences terminal, with 2 or 3-flowered cymes;

pedicels 7.5–40 mm long, sparsely glandular to short pilose. Calyx 7–12 mm long, the membranes flat, long pilose and with glandular trichomes. Corollas narrowly funnelform, white or rarely lavender, the tube 7–16 mm long, the lobes 6.5–10 mm long, 3–5 mm wide, obtuse to truncate. Stamens unequally inserted on the upper tube; stigmas adjacent to the anthers, and included. Capsules 4.4–6.3 mm long, dehiscing the full length of the valves, or nearly so. Seeds 1 per locule, 3–4 mm long, not mucilaginous when wet. Flowering in spring and with summer-fall rains.

Canyons and rocky slopes generally in the Ajo and Diablo mountains, especially above 3000 feet.

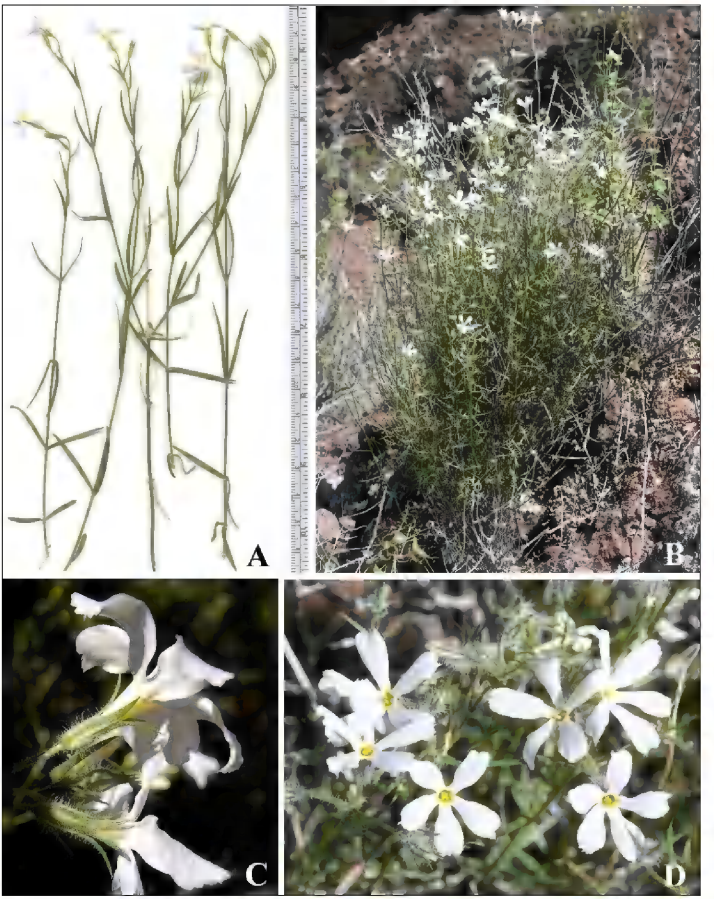

Figure 15. *Phlox tenuifolia*. (A) Trail to Bull Pasture, 21 Sep 2008. (B & D) Estes Canyon, 12 Mar 2005. (C) La Milagrosa Trail, Santa Catalina Mts, Pima Co., 22 Mar 2015, photo by Sue Carnahan.

Eastward and northward in Arizona, mostly above the desert, New Mexico, northern Sonora east of the flora area, and Chihuahua.

OP: Ajo Mts, *Goodding 31 Oct 1938*. Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 550*. Bull Pasture Trail, 5 Nov 1977, *Bowers 932*. Diablo Canyon, 12 May 1988, *Baker 7606* (ASU). Middle fork of Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-343* (ORPI). Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-21*.

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Part 2. CHECKLIST. Phytoneuron 2013-27: 1–30.

Part 3. FERNS, LYCOPODS, & GYMNOSPERMS. Phytoneuron 2013-37: 1–46.

Part 4. MAGNOLIIDS. Phytoneuron 2013-38: 1–9.

Part 5. MONOCOTS EXCEPT GRASSES. Phytoneuron 2013-76: 1–59.

Part 6. POACEAE – GRASS FAMILY. Phytoneuron 2014-35: 1–139.

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Part 16. MALPIGHIACEAE to MORACEAE. Phytoneuron 2015-60: 1–54.

Part 17. NYCTAGINACEAE to PLUMBAGINACEAE. Phytoneuron 2016-34: 1–77.

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NEW COMBINATIONS IN *BROMUS SITCHENSIS* (POACEAE)

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ABSTRACT

New combinations are proposed to bring a complex of intergrading taxa into *Bromus sitchensis* Trin., a single, variable species: **B. sitchensis** Trin. var. **carinatus** (Hook. & Arn.) R.E. Brainerd & Otting, comb. nov., **B. sitchensis** Trin. var. **maritimus** (Piper) Otting & R.E. Brainerd, comb. nov., and **B. sitchensis** Trin. var. **polyanthus** (Scribn. ex Shear) R.E. Brainerd & Otting, comb. nov. A key to the varieties is provided.

Six native *Bromus* taxa in western North America are characterized by strongly keeled lemmas and glumes with 3–7(–9) veins. These taxa are among the members of *Bromus* sect. *Ceratochloa*. They have been recognized as species or have been combined with each other in various ways (Table 1). These taxa are distinguished mainly by the hairiness of the sheaths, ligules, leaf blades, glumes, or lemmas, the size of the culms, panicles, and spikelets, whether the panicle branches are erect, spreading, or reflexed, and the length of the lemma awns (Table 2). Theoretically most of these variants are perennial and one is annual or biennial, but the shorter-lived plants do not always die on schedule. Intermediate plants are common, and plants that key to one taxon may sometimes be found in the supposed range associated with another taxon. References disagree about how to identify these taxa (Hitchcock et al. 1969; Pavlick 2003; Pavlick & Anderton 2007; Welsh et al. 2003) and the identification keys provided tend to disagree with annotations on herbarium specimens (specimens at WTU annotated by Pavlick in 1991 and 1992 compared to Pavlick 2003 and Pavlick and Anderton 2007).

Intense study of the group (e.g., Pavlick 2003) has not produced a taxonomically satisfying resolution to this geographic and morphological pattern of variation. The problem seems intrinsic to the plants and probably results from their methods of reproduction. At least some plants in all the taxa have anthers about 0.2–1 mm long, remaining enclosed in the cleistogamous florets; and at least some plants in all taxa have anthers about 3–5(–6) mm long and exserted. The differences may be facultative and induced by the environment (Hitchcock et al. 1969). The mix of selfing and outcrossing creates a pattern of variation that does not fit simple species concepts. These grasses produce at least partially fertile hybrids when crossed and can be thought of as a single, successful, highly polymorphic taxon (Stebbins 1981; Welsh et al. 2003).

We find that at arm's length one can group the plants into five or six basic types and that each type has a characteristic habitat and range (Table 2). The more one delves into matters of lemma hairiness or awn length, the more difficult it becomes to separate the groups. Therefore, we conclude that there is value in recognizing all six of the variants taxonomically, although they are not fully distinct. In preparation for the *Bromus* treatment for the second edition of the Flora of the Pacific Northwest, we recognize all of them as varieties of the first published species name, *B. sitchensis* Trin. Two have already been named as such, *B. s.* var. *aleutensis* (Trin. ex Griseb.) Hultén and *B. s.* var. *mariginatus* (Nees ex Steud.) B. Boivin, of course implying *B. s.* var. *sitchensis*. Here we formally make the combinations necessary to include the remaining three taxa into *B. sitchensis*.

Bromus sitchensis Trin. var. **carinatus** (Hook. & Arn.) R.E. Brainerd & Otting, **comb. nov.** Basionym: *Bromus carinatus* Hook. & Arn., Bot. Beechey Voy. 403. 1841 [1840].

Bromus sitchensis Trin. var. **maritimus** (Piper) Otting and R.E. Brainerd, **comb. nov.** Basionym: *Bromus marginatus* subsp. *maritimus* Piper, Proc. Biol. Soc. Washington 18: 148. 1905. *Bromus maritimus* (Piper) A. Hitchc. in Jepson, Fl. Calif. 1: 177. 1912.

Bromus sitchensis Trin. var. **polyanthus** (Scribn. ex Shear) R.E. Brainerd & Otting, **comb. nov**. Basionym: *Bromus polyanthus* Scribn. ex Shear, Bull. Div. Agrostol., U.S.D.A. 23: 56. 1900.

Key to the varieties of *Bromus sitchensis*

1. Panicles dense, the pedicels or branches erect and mostly shorter than the spikelets; culms 20–70 cm tall; habitat coastal sands ..... var. **maritimus**
1. Panicles loose to compact, at least some of the pedicels and panicle branches longer than the spikelets, erect, ascending, spreading or reflexed; culms 30–180 cm tall; habitat various, including coastal sands; widespread.

    2. Some lower panicle branches 10–20 cm, spreading to reflexed, with 1–2(–3) spikelets borne at the tip; ligules 3–8 mm; leaf sheaths glabrous to sparsely pilose; lemmas usually glabrous (sometimes short-hairy) ..... var. **sitchensis**
    2. Lower panicle branches usually < 10 cm, erect, ascending, spreading or reflexed, with 1–5 spikelets variously arranged, borne at the tip or sometimes to near the base; ligules 1–5(–6) mm; leaf sheaths and lemmas variously hairy or glabrous.

        3. Panicle branches erect to ascending, generally with 1–2(–3) spikelets borne at the tip; ligules (1–)3.5–5 mm; leaf veins relatively narrow, mostly < 1/3 as broad as the area between them; spikelets with 3–6 florets; culms often > 3 mm thick at mid-length ..... var. **aleutensis**
        3. Panicle branches erect, ascending, spreading or reflexed, with 1–5 spikelets borne variously, often not limited to the tip; ligules 1–3(–6) mm; leaf veins relatively wide, mostly at least ½ as broad as the area between them; spikelets with 4–11 florets; culms often < 3(–4) mm thick at mid-length.

            4. Uppermost leaf sheath margins glabrous; lemmas glabrous, sometimes scabrous ..... var. **polyanthus**
            4. Uppermost leaf sheath margins usually hairy; lemmas hairy, scabrous, or glabrous.

                5. Most awns 8–17 mm; panicle branches mostly spreading to reflexed .. var. **carinatus**
                5. Most awns 4–7 mm; panicle branches mostly erect to ascending ..... var. **marginatus**

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Table 1. Selected nomenclatural history of plants of the *Bromus sitchensis* complex.

	in *Bromus carinatus*	in *Bromus sitchensis*
Bromus aleutensis Trin. ex Griseb.		*B. s.* var. *aleutensis* (Trin. ex Griseb.) Hultén
B. carinatus Hook. & Arn.	*B. c.* var. *carinatus*	*B. s.* var. *carinatus* hoc. loc.
B. marginatus (Nees ex Steud.)	*B. c.* var. *marginatus* (Nees) Barkworth & Anderton	*B. s.* var. *marginatus* (Nees ex Steud.) B. Boivin
B. maritimus (Piper) A. Hitchc.	*B. c.* var. *maritimus* (Piper) C.L. Hitchc.	*B. s.* var. *maritimus* hoc. loc.
B. polyanthus Scrib. ex Shear	Synonymized with *B. carinatus* (Cronquist et al. 1977)	*B. s.* var. *polyanthus* hoc. loc.
B. sitchensis Trin.		*B. s.* var. *sitchensis*

Table 2. Comparison of the six taxa in the *Bromus sitchensis* complex. Data from Pavlick and Anderton (2007).

Trait	var. *aleutensis*	var. *carinatus*	var. *marginatus*	var. *maritimus*	var. *polyanthus*	var. *sitchensis*
Range	Mainly Pacific coast Aleutians to NW WA; inland in B.C. and WA	Widespread, more common west of Cascade / Sierra axis	mostly in and east of the Cascade / Sierra axis	Coastal	Mainly central Rocky Mts, but extending to BC, CA, NM, and west Texas	Aleutian Islands to southern CA, coastal or coast mountains
Habitat	disturbed soil, lake shores	meadows, savannah	grasslands	cliffs, bluffs	grasslands	forest edge
Duration	perennial	annual or biennial	perennial	perennial	perennial	perennial
Height	40–130 cm	50–100 cm	45–120(180) cm	20–80 cm	60–120 cm	120–180 cm
Culm thickness	3–7 mm	usually < 3mm	to 3 mm	to 3 mm	to 3 mm	3–5 mm
Sheath surface	hairy	glabrous or retrorsely hairy	usually sparsely retrorsely hairy	usually smooth or scabrous	usually smooth or scabrous	glabrous or sparsely pilose
Sheath throat	pilose	usually pilose	always pilose	not pilose	glabrous	glabrous or sparsely pilose
Leaf width	6–15 mm	3–6(9) mm	1–12 mm	6–8 mm	2–9 mm	(2)5–20 mm
Inflorescence	erect	lax	erect	erect to sl. lax	erect	lax, nodding
Inflorescence	open to somewhat contracted	open	open to somewhat contracted	dense	open to somewhat contracted	open
Panicle branches	lowest stiffly ascending	ascending or spreading (reflexed)	erect or ascending	erect	erect, ascending, or spreading	spreading to drooping
Long branch L	to 10 cm	usually < 10 cm	< 10 cm	<10 cm	< 10 cm	> 10 cm
Pedicels	some > spikelets	some > spikelets	some > spikelets	< spikelets	some > spikelets	some > spikelets
Lemma awn L	(3)5–10 mm	8–17 mm	4–7 mm	(2)4–7 mm	4–7 mm	5–10 mm
2n =	56	28, 56	42	56	56	42, 56

Serviss, B.E., K.B. Serviss, and J.H. Peck. 2016. *Podocarpus macrophyllus* (Podocarpaceae): A new species, genus, and family for the Arkansas flora. Phytoneuron 2016-37: 1–4. Published 31 May 2016. ISSN 2153 733X

PODOCARPUS MACROPHYLLUS (PODOCARPACEAE): A NEW SPECIES, GENUS, AND FAMILY FOR THE ARKANSAS FLORA

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ABSTRACT

Podocarpus macrophyllus (Thunb.) Sweet is reported here as new to the Arkansas flora. This record also is the first documentation of the Podocarpaceae family outside of cultivation in the state. One or two spontaneous plants of *P. macrophyllus* were discovered growing in disturbed, urban woods along a riparian zone in Clark County. Photographs of plants of the species in habitat are provided.

Podocarpus is a genus of about 100 species of dioecious or rarely monoecious, evergreen shrubs and trees widely distributed over subtropical and tropical regions worldwide, with a few species also occurring in warm–temperate zones (Bailey & Bailey 1976; Krüssmann 1972; Fu et al. 1999; Byng 2015). It is the largest genus in the Podocarpaceae, which itself is the second largest family of conifers after the Pinaceae (Mill 2014). A number of *Podocarpus* species are cultivated; however, relatively few are cold–hardy (Bailey & Bailey 1976; Krüssmann 1972), which limits their use as ornamentals in much of the USA. Species of *Podocarpus* are characterized by their alternate, spirally arranged or sometimes subopposite to opposite, usually linear–lanceolate or linear–elliptic, simple leaves, typically solitary ovulate cones, which often have the basal bracts fused to form a "receptacle" that becomes swollen, fleshy, and brightly colored at maturity, and seeds that are enclosed in an epimatium that is sometimes fleshy (Fu et al. 1999; Byng 2015).

Podocarpus macrophyllus (Thunb.) Sweet (big–leaf podocarp, yew plum pine) is a large, evergreen shrub or small tree to 20 meters tall that is native to China and Japan (Bailey & Bailey 1976; Krüssmann 1972; Fu et al. 1999). This species is grown in the southern USA, including Arkansas, as an ornamental for its glossy, tightly clustered, evergreen foliage, conspicuous blue to blue–green–colored ovulate cones that at maturity become red to purplish–red in color with a purplish–black–colored seed at the apex, attractive growth form, and ease of cultivation. It prefers well–drained, acidic soil in full sun to partial shade, but it also is tolerant of high shade conditions.

Podocarpus macrophyllus has been reported previously as a component of the naturalized floras of Alabama and Florida (Wunderlin & Hansen 2011; Barger et al. 2012; Kartesz 2015; Weakley 2015; USDA, NRCS 2016) — our record from Arkansas marks only the third state from which *P. macrophyllus* has been documented outside of cultivation. The presence of naturalized *P.*

macrophyllus in Arkansas also is the first occurrence of the genus *Podocarpus* and the Podocarpaceae family in the state's flora.

In 2016, one to two spontaneous plants of *Podocarpus macrophyllus* were documented within a highly disturbed, urban woods/greenbelt along a riparian zone in Clark County (Fig. 1). The site is surrounded on all sides by residential areas. In addition to *P. macrophyllus*, a number of other non–native species were present and naturalized, including *Albizia julibrissin* (mimosa), *Hedera helix* (English ivy), *Ilex cornuta* (Chinese holly), *Ligustrum lucidum* (glossy privet), *Ligustrum sinense* (Chinese privet), *Liriodendron tulipifera* (yellow poplar—native in Arkansas but only to Crowley's Ridge—naturalized elsewhere in the state), *Liriope muscari* (blue lilyturf), *Lonicera japonica* (Japanese honeysuckle), *Lycoris radiata* (surprise lily), *Magnolia grandiflora* (southern magnolia—apparently native west of the Mississippi River), *Nandina domestica* (heavenly bamboo), *Photina serratifolia* (Chinese photina), and *Triadica sebifera* (Chinese tallow tree). The larger of the two *P. macrophyllus* plants was a sapling (juvenile) ca. 1.4 meters tall (Fig. 2). The "second" plant was smaller, ca. 58 cm tall, and immediately adjacent to the larger plant. We could not unequivocally ascertain if the smaller plant was a distinct plant or merely a root sucker originating from the larger individual.

Voucher specimen: **Arkansas.** Clark Co.: One to two spontaneous plants growing along bank of small stream in disturbed, urban woods/greenbelt along riparian zone, off of O'Connell Street, adjacent to the intersection of O'Connell Street and 18th Street, Arkadelphia, 14 May 2016, *Serviss 8337* (HEND).

Figure 1. Spontaneous plant of *P. macrophyllus* in disturbed, urban woods in Clark County, Arkansas (this plant was ca. 1.4 m tall). (A) Plant and habit. (B) Close–up of base of plant showing branching pattern and main stem.

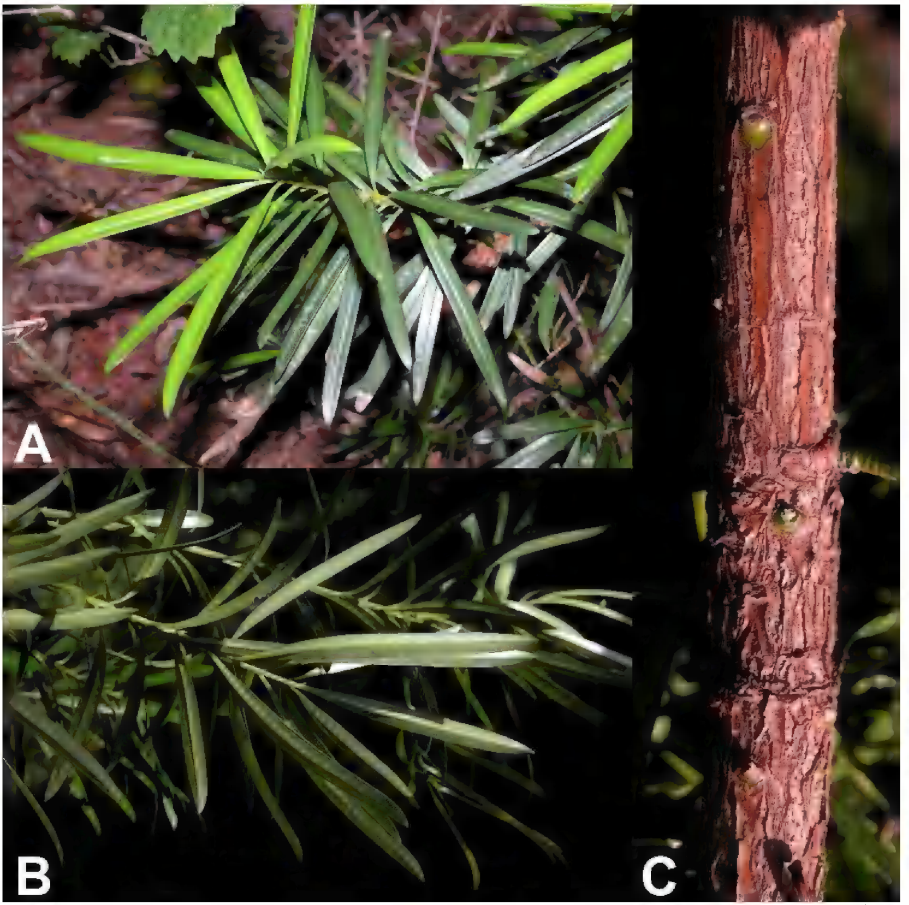

Figure 2. Close–up photographs of leaves and bark from the larger spontaneous plant of *P. macrophyllus*. (A–B) Leaves. (C) Young bark.

No cultivated plants of *Podocarpus macrophyllus* were observed in the immediate vicinity of the location of the spontaneous plant(s); however, both microsporangiate and megasporangiate/ovulate plants of the species are cultivated in the Arkadelphia area, some of which are present no more than 3.5 km from the location. Dispersal of seeds (possibly via birds) from cultivated megasporangiate plants provides a plausible explanation as to the origin of the spontaneous plant(s). The seeds of *Podocarpus* species, in general, are animal–dispersed (Buchholz & Gray 1948; Givnish 1980; Geldenhuys 1993).

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A NEW SUBSPECIES OF *HELIANTHUS PARADOXUS* (ASTERACEAE) IN THE CUATRO CIÉNEGAS BASIN, COAHUILA

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ABSTRACT

Helianthus paradoxus subsp. **cuatrocienegensis** Sivinski **subsp. nov.** is described from wetlands of the Cuatro Ciénegas basin in Coahuila, Mexico. It differs from more northern populations of subsp. *paradoxus* by its bushy branching pattern of dense, well-developed flowering branches from the base of the plant to near the middle of the central stem, its longer outer whorl of phyllaries that are subulate and usually reach half or more the length of the ray flowers, and its central paleae that have shorter, acute terminal lobes with a short mucro.

As the endangered species botanist for the State of New Mexico, I had the opportunity to visit, study and sometimes discover the known populations of *Helianthus paradoxus* Heiser over a period of almost three decades. This species was listed as threatened by the U.S. Fish and Wildlife Service on October 20, 1999 (64 FR 56582-56590) and I drafted its recovery plan in 2004 (U.S. Fish and Wildlife Service. 2005). I have always been impressed at how little morphological variation there is between the widely disjunct *H. paradoxus* populations of New Mexico and west Texas. This species is infrequent and isolated in saline or gypseous ciénega (wet meadow) habitats that are sometimes separated by distances of more than 200 km. Such morphological consistency allowed Heiser (1958) to describe the species from only two herbarium specimens –– with a holotype from near Fort Stockton in west Texas and a paratype from Grants in west-central New Mexico (Sivinski 2003), which are more than 500 km apart.

While accompanying invertebrate biologists on a collecting trip to Cuatro Ciénegas Biosphere Reserve in 2011, I frequently observed an annual sunflower in gypseous ciénegas at most of the springs and spring runs we visited. It is similar to *Helianthus paradoxus*, but with some significant morphological differences. Subsequent SNP genetic analysis of a leaf fragment clustered this Coahuila sunflower with *H. paradoxus*, yet it is quite different genetically from populations in New Mexico and Texas (Loren Rieseberg, pers. comm. 2016). This Coahuila population is about 460 km south of the nearest known *H. paradoxus* populations in west Texas. Unfortunately, I was not permitted to take voucher specimens of plants from Mexico and must use the only existing herbarium specimen I can find as the type.

Helianthus paradoxus Heiser subsp. **cuatrocienegensis** Sivinski, **subsp. nov.** **TYPE: MEXICO. Coahuila.** Poso de Tio Candido, 17 Aug 1967, *D.J. Pinkava 4111* with Cole and Minckley (holotype: ASU). Figures 1–4.

Differs from subsp. *paradoxus* in large plants having well developed flowering branches at every node from the base of the plant to about the middle of the central stem, lanceolate-subulate outer phyllaries that reach half or more the length of the ray corollas, and terminal lobes of central paleae 1.0–1.5 mm long, acute and often mucronate.

Figure 1. Holotype of *Helianthus paradoxus* subsp. *cuatrocienegensis*, ASU.

Figure 2. Growth form of a single, 2 m tall plant of *Helianthus paradoxus* subsp. *cuatrocienegensis* just prior to flowering near Posas Azules Field Station (26.80589° -102.01636°), 21 Sep 2011. Elongate phyllaries are evident on the immature capitula.

Figure 3. *Helianthus paradoxus* subsp. *cuatrocienegensis* capitulum morphology. A. Involucre with long, subulate outer phyllaries. B. Reddish brown disk with central paleae lacking white cilia. C. Central paleae in previous year's flower head showing short, acute terminal lobes.

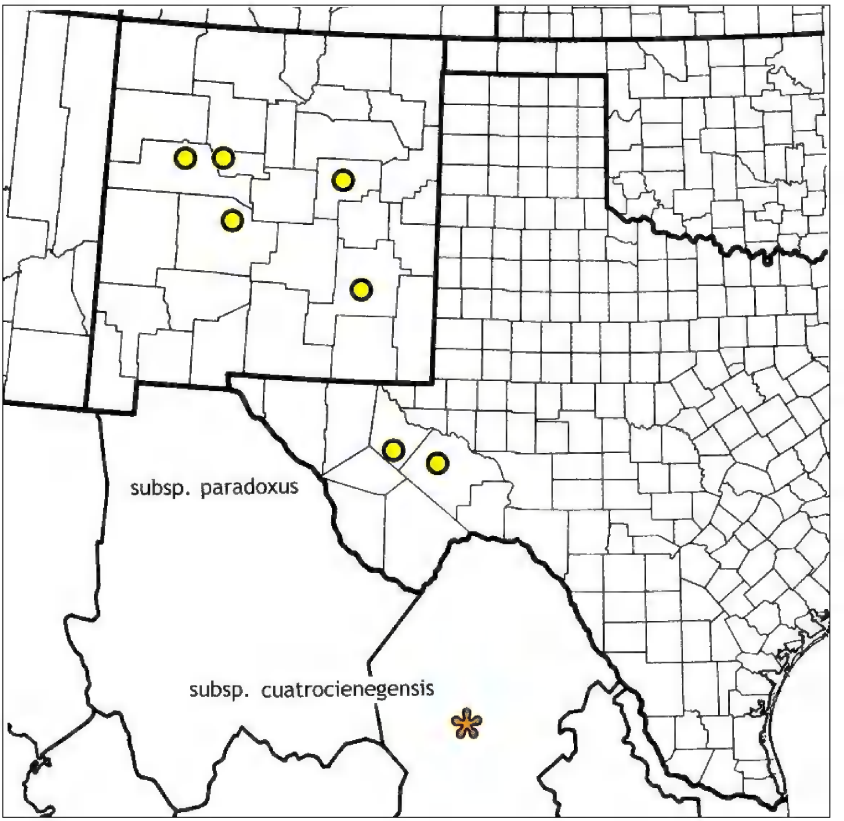

Figure 4. Distribution of *Helianthus paradoxus* subsp. *paradoxus* and subsp. *cuatrocienegensis*.

Helianthus paradoxus is an annual sunflower with lanceolate leaves that are strongly 3-nerved, coriaceous, and usually entire on the margins (rarely with 1 or 2 coarse teeth on each side). The lower leaves at the stem base are opposite and subsequent leaves further up the stem are alternate. Its flower heads are relatively small (3-5 cm across – including rays) with an involucre of narrowly lanceolate phyllaries. Salt tolerance is remarkable in this species, which always occurs on moist soil in or on the margins of aridland spring ciénegas, spring runs and seeps with high concentrations of salts –– frequently gypsum (USFW 2005). The wetland sunflower in the Cuatro Ciénegas basin is consistent with all these habitat and morphological traits, but differs as described above. Its substantial morphological similarities, habitat fidelity, and genetic clustering with northern populations of *H. paradoxus* lead here to an infraspecific rank for subspecies *cuatrocienegensis*. Subspecies *paradoxus* (USA populations) has shorter, flatter outer phyllaries that reach less than one third the length of the ray corollas, and central paleae with longer (1.8–3.0 mm) acuminate terminal lobes without a mucro. These northern plants may occasionally branch near the base, but any such branching is not so densely developed and the overall form of the plants is not bushy. Depauperate specimens of both subspecies can lack basal branches and produce only a single, strict central stem.

The type specimen for subsp. *cuatrocienegensis* was initially identified as "aff. *Helianthus petiolaris* Nutt." That species is readily distinguished from *H. paradoxus* by its smaller, thinner leaves, central paleae fringed with white cilia, and upland habitats with drier, sandy soils.

Other locations. The type locality at Poso de Tio Candido is deep within the Cuatro Ciénegas Biosphere Reserve, but subsp. *cuatrocienegensis* can be seen more easily at spring seeps near and within the Highway 30 R-O-W about 10 km southwest of Municipio de Cuatro Ciénegas (26.91319° -102.14048°). It is also accessible (for a fee) in the ciénega and spring runs at the recreation area around Posa de Mesquites (26.91789° -102.10399°). Further within the Reserve several scattered plants were noted in sinkhole seeps at Los Hundidos (26.87162° -102.02108°), but it was exceptionally abundant and widespread in the extensive ciénegas of Posas Azules (26.80589° -102.01636°). This locally common wetland sunflower likely occurs in great numbers throughout most ciénega habitats in the Cuatro Ciénegas basin. It is surprising this large abundant plant has not been identified before this time and is so infrequently collected.

Habitat. Both *Helianthus paradoxus* subspecies occupy low to medium elevation springs and seeps with saline/alkaline soils. Known elevations in the Cuatro Ciénegas basin range from 710-760 m (2300-2500 ft). The plant associations are almost entirely wet meadow herbaceous vegetation called ciénegas by biologists and local people but also occasionally referred to as inland salt marsh (Van Auken & Bush 1998). Plant species common to both southern and northern *H. paradoxus* habitats include *Distichlis spicata, Sporobolus airoides, Phragmites australis, Typha domingensis, Flaveria chlorifolia, Eustoma exaltatum*, and *Limonium limbatum*. The northern subspecies *paradoxus* populations are sometimes associated with rare ciénega plants such as *Cirsium wrightii* and *Agalinis calycina*, while subspecies *cuatrocienegensis* occurs with *Cirsium coahuilense*, *Sabatia tuberculata*, and other local ciénega endemics. The wetlands of the Cuatro Ciénegas basin abound with endemic flora and fauna, but all are currently threatened by aquifer depletion and non-native species (Hendrickson et al. 2008).

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David Lightfoot and Karen Wright, UNM Museum of Southwestern Biology, allowed me to accompany them on their collecting trip to the Cuatro Ciénegas basin, which introduced me to the most biologically diverse desert wetlands in North America. I also thank Loren Rieseberg for genetic analysis of the leaf fragment I sent to him. Phil Tonne, Collection Manager at UNM Herbarium, made the type specimen image and he and Tim Lowrey, UNM Herbarium Curator, reviewed the manuscript. Guy Nesom also reviewed the manuscript and made the distribution map.

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ERYTHRINA HERBACEA (FABACEAE) AND TWO CLOSE RELATIVES FROM MEXICO

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ABSTRACT

Erythrina herbacea L. is widespread in the southeastern USA, reaching southern Texas at its southwestern limit. An apparently related population system (previously identified as *E. herbacea*) in southeastern Nuevo León and adjacent Tamaulipas, Mexico, is described here as **Erythrina sierra** Nesom, **sp. nov.** –– it differs from *E. herbacea* in its strigose-villous to villous-puberulent calyces and young stems, petioles and petiolules without prickles, and its short-pedicellate flowers borne singly in relatively compact clusters. The strictly Mexican *Erythrina herbacea* subsp. *nigrorosea* Krukoff & Barneby is raised in rank to **Erythrina nigrorosea** (Krukoff & Barneby) Nesom, **comb. et stat. nov**. These plants differ from typical *E. herbacea* in their larger and consistently shrubby to tree-like habit, flowers in compact clusters, pinkish corollas, and tendency toward dark calyces. *Erythrina nigrorosea* occurs from San Luis Potosí and southeastern Tamaulipas south to Oaxaca and Chiapas.

In previous studies of *Erythrina* (Krukoff & Barneby 1974; Krukoff 1982), *E. herbacea* L. has been considered to comprise two entities — subsp. *herbacea* of the southeastern USA and the Mexican subsp. *nigrorosea*, from Chiapas and Oaxaca north into Tamaulipas. They are treated here as distinct species with widely disjunct geographic distributions. Additionally, plants from an area of southeastern Nuevo León and adjacent Tamaulipas, Mexico, represent a previously undescribed species presumably closely related to *E. herbacea*. The three species are mapped in Figures 2 and 9.

ERYTHRINA HERBACEA L., Sp. Pl. 2: 706. 1753. *Corallodendron herbaceum* (L.) Kuntze, Revis. Gen. Pl. 1: 172. 1891. **LECTOTYPE** (Reveal in Turland & Jarvis, Taxon 46: 469. 1997): **USA**. **[South Carolina]**. Without other data (Catesby, Nat. Hist. Carolina 2: t. 49. 1736. Figure 2).

Erythrina herbacea forma *albiflora* Moffler & Crewz, Phytologia 52: 288. 1983. **TYPE**: **USA**. **Florida**. Pinellas Co.: Fort DeSoto Park, St. Jean Key, W of State Rd 693 in coastal thicket, (T33S, R16E, sec. 8), large shrub to 3 m, associates *Quercus geminata*, *Sabal palmetto*, *Dalbergia ecastaphyllum*, 24 Apr 1981, *D.W. Crewz 2132* (holotype: STPE; isotype: USF digital image!).
Described from a single white-flowered plant in a population of red-flowered ones.

Erythrina arborea (Chapm.) Small, Fl. S.E. U.S., 647. 1903. *Erythrina herbacea* var. *arborea* Chapm., Fl. South. U.S. (ed. 3), 117. 1897. **TYPE**: **USA**. **Florida**. Protologue: "Stems woody, 10 ft–20 ft high, widely branching at the summit; racemes axillary, few-flowered; flowers smaller; legume erect. — South Florida." A specimen at MO is possible type material: the handwritten label says "S Florida. Feb 1872, Dr. Chapman [s.n.]." The collection has no leaves or flowers, just three long branches or portions of branches.

Xyphanthus hederifolius Raf., Fl. Ludov., 103. 1817. *Erythrina hederifolia* (Raf.) Spreng., Syst. Veg. 3: 244. 1826. **TYPE**: **USA**. **[Louisiana]**. Rafinesque noted in his description of the genus *Xyphanthus* that "This genus differs from *Erythrina* by the shape of the calyx, which is not bilobated; the *E. herbacea* belongs perhaps to it." The description of the species is detailed and diagnostic ("having much affinity with *Erythrina herbacea*") but refers only to "Raf.––*Erythrina* Rob. p. 503."

Erythrina rubicunda Jacq., Fragm. Bot., 75, t. 119. 1809. **TYPE**: Jacquin knew the species from gardens in Holland, where he thought the name *Erthrythina herbacea* was misapplied. "Ex Hollandia in hortos nostrates ante plures annos migravit haec planta sine indicata sub erroneo Erythrinae herbaceae titulo. Ad nullum ex cognitis reducere potui, hinc ceu novam speciem propono." No specimen was cited but the color illustration unequivocally shows *Erythrina herbacea* L.

Figure 1. Inflorescence of *Erythrina herbacea*. Bradford Co., Florida, 2 Apr 2005, *Bitter 113* (FLAS).

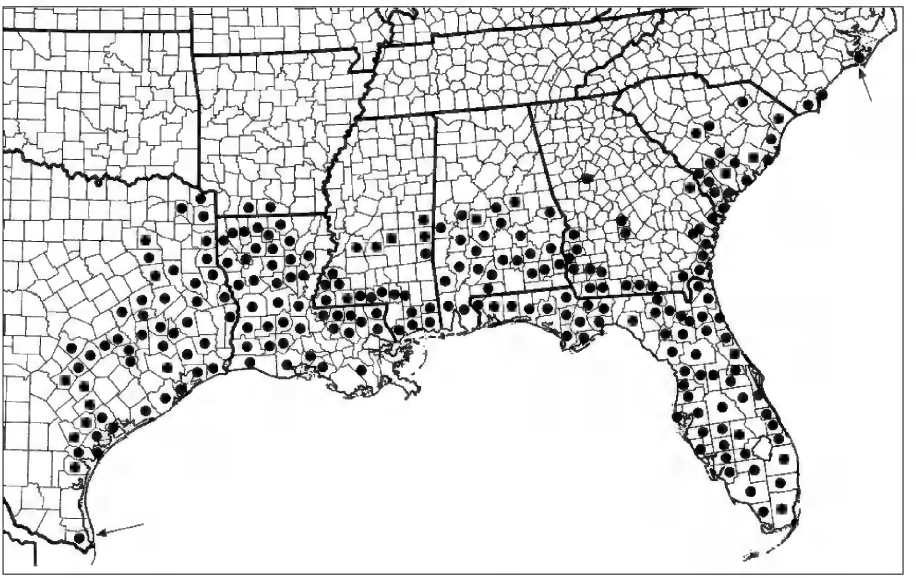

Figure 2. Distribution of *Erythrina herbacea*. Data from various literature and internet sources and collections at TEX-LL and SMU-BRIT-VDB. Arrows show northernmost locality in Carteret Co., North Carolina, and southernmost locality in Cameron Co., Texas. The species is not known to occur in Mexico.

Erythrina herbacea occurs natively in Texas as far south as Cameron Co. (Fig. 1), where known from several collections (TEX database 2016), but it has not been documented from Mexico. Diggs et al. (1999) included the species in their treatment of the north-central Texas flora based on a plant of *E. herbacea* supposedly escaped from cultivation in Tarrant Co., Texas (BRIT; along fence of residence on East Davis Street in Fort Worth), but there is no evidence of its naturalized persistence there. An occurrence in Payne Co., Oklahoma, mapped by Kartesz (2014) is based on a specimen from cultivation (Amy Buthod, pers. comm. 2016).

Catesby's description and illustration (Fig. 2) of the root of *Erythrina herbacea* are not only the first but perhaps still the best available: "The Root of this Plant resembles that of Briony, being large at Top, running down into the Earth four or five Feet, white within, and covered with a brown Rind; some of them so large, that they weigh upwards of twenty Pounds." The swelling taproot of a young plant is shown in Figure 3. In mature plants with numerous stems from the base (Fig. 4), new shoots apparently are produced from buds of the broad caudex region at the taproot apex.

Figure 3. Mark Catesby's 1736 illustration of *Erythrina herbacea* L., which serves as the lectotype of the species.

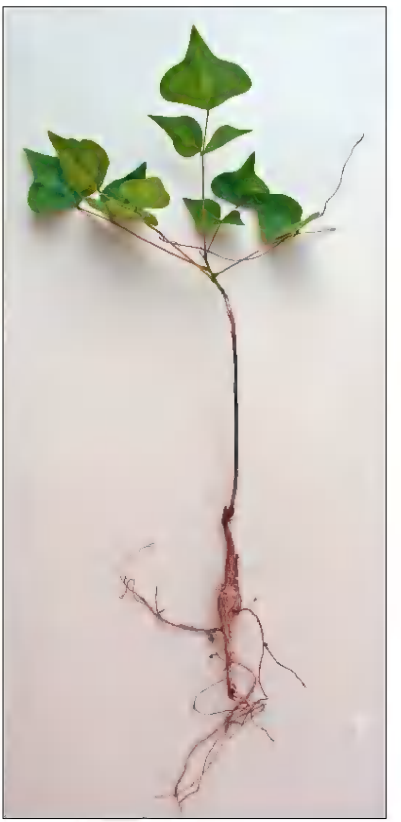

Figure 4. Potentially massive taproot of a young plant of *Erythrina herbacea* from Florida. Photo from Mark Hutchinson (2011), with permission.

Figure 5. *Erythrina herbacea* from Hernando Co., Florida. Multicipital apex of tuberous taproot. Photo by Mark Hutchinson.

Figure 6. *Erythrina herbacea* from Hernando Co., Florida. Multiple shoots (axillary?) arising from near apex of branch previously cut off near the ground. Photo by Mark Hutchinson.

Over most of the range of *Erythrina herbacea*, the plants commonly are herbaceous perennials with flowers and leaves on separate stems (flowers borne on leafless stems) arising separately from the broad caudex/ root apex. Flowers and leaves often, however, are borne on the same stem — the flowers usually in a dense to loose raceme above the leaves but sometimes axillary in the proximal portion of the inflorescence. In southern Florida and occasionally elsewhere, axillary buds (presumably) of stem bases persisting from the previous year may produce new shoots and the plants are shrubby (e.g., see Fig. 6).

Figure 7. Growth habit of *Erythrina herbacea*, showing numerous stems arising from broad caudex/root apex. Texas, locality otherwise unspecified. Photo by Sally and Andy Wasowski, from Lady Bird Johnson Wildflower Center's collection of plant images, NPIN Image Id: 22416.

ERYTHRINA SIERRA Nesom, **sp. nov. TYPE: MEXICO. Tamaulipas**. Mpio. Hidalgo: Into the sierra, 14.9 mi W of Hotel Santa Engracia, 4.3 mi W of the Adelaida-Guayabas jct, 24° 01' N, 99° 34' W, side of steep canyon, NW-facing slope, primarily oaks (*Q. rysophylla* dominant) with *Ungnadia* and large Lauraceae, 560-570 m, 17 Apr 1988, *G.L. Nesom 6349* with L. Hernandez, M. Martinez, and J. Jimenez (TEX). Figure 5.

Similar to *Erythrina herbacea* in its low habit and narrow, red corollas, different in its larger stem prickles, petiole and petiolules without prickles, strigose-villous to villous-puberulent calyces and young stems, and its short-pedicellate flowers borne in a relatively compact distal cluster, the inflorescence not elongating and separating into distinct whorls.

UNIVERSITY OF
TEXAS
HERBARIUM
HOLOTYPE OF
Erythrina sierra Nesom
PLANTS OF MEXICO
Erythrina herbacea L.
TAMAULIPAS: Mpio. Hidalgo, into the sierra, 14.9 mi W of Hotel Santa Engracia, 4.3 mi W of the Adelaida-Guayabas jct; side of steep canyon, NW-facing slope; primarily oaks (Q. rysophylla dominant) with large Lauraceae, Ungnadia;
560-570 m; 24°01'N, 99 34'W
small shrub, mostly without leaves, 3 feet tall. Flowers bright red.
17 Apr 1968
Guy Nesom 6349
with L. Hernandez, M. Martinez, J. Jimenez
UNIVERSITY OF TEXAS HERBARIUM (TEX-LL)
00221005

Figure 8. Holotype of *Erythrina sierra*.

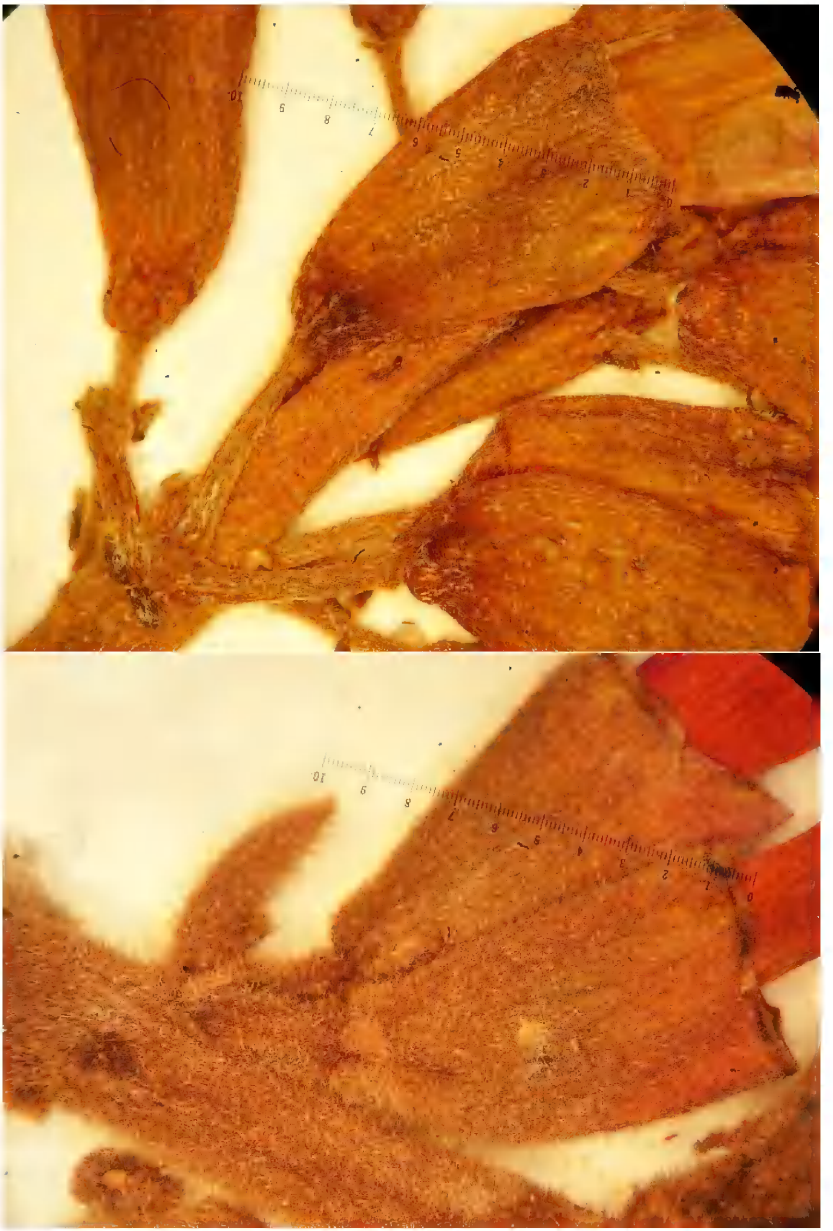

Figure 9. Calyces of *Erythrina sierra* showing variation in vestiture.

Shrubs 0.5–2 m tall; producing abundant, slightly recurving prickles 4–9 mm long, young stems and inflorescence axis moderately to densely strigose-villous to villosulous-puberulent with dark hairs, glabrescent. **Leaves** arising from clustered nodes at stem tips, 3-foliolate, glabrous, rachis and petiolules apparently without prickles; leaflets ovate to triangular, deltate, or depressed-ovate, barely if at all 3-lobed, 33–45 mm long, 24–50 mm wide at base, base mostly truncate to broadly obtuse, apex obtuse to acute but not acuminate, sometimes retuse. **Flowers** mostly borne singly, sometimes in fascicles of 2–3, not in obvious whorls, inflorescence axis at maturity 5–13 cm; pedicels 2–3(–5) mm. **Calyx** moderately to densely strigose-villous to villosulous-puberulent, tube 8–11 mm, apex truncate. **Corolla** banner pseudotubular, enclosing keel and wings, (2.5–)3–5(–6) cm, red to scarlet. **Fruits** subcylindric with shallow constrictions, 6–10 cm. **Seeds** 4–8, 10–13 mm long, orange-red.

Additional collections examined. MEXICO. Nuevo León. Mpio. Zaragoza: from Hwy jct "Y" ["La Ygriega" S of Galeana] toward Los Tepozanes, shale ravine, 1570 m, 26 Mar 1993, *Hinton & et al. 22758* (HINT digital image, TEX); Dulces Nombres, N.L., and just E of border into Tamaulipas, E side Cerro Linadero, steep, shaded, grassy, S-facing slopes in canyon, 1900 m, 9 Aug 1948, *Meyer & Rogers 2895* (MO). **Tamaulipas**. Mpio. Hidalgo: Purificación, on cliffs in oak woods, 1530 m, 28 Apr 1995, *Hinton et al. 25266* (HINT digital image, MO); Mimbres toward [->] Dulces Nombres, mixed forest, 1935 m, 5 Jun 1994, *Hinton et al. 24307* (HINT digital image, MO). [Mpio. San Carlos]: ca. 10 mi NW of San Carlos, 15 Mar 1976, *Whalen 287* (TEX).

The morphological distinction of *Erythrina sierra* is shown in the following couplet.

1. Stems and inflorescence axis glabrous or minutely puberulent and glabrescent; stem prickles 2–5(–7) mm long; rachis and petiolule sometimes with scattered minute prickles; leaflet blades ovate-acuminate to hastate-ovate, trilobed to subtrilobed, apices acuminate; flowers borne singly or usually in fascicles of 2–4 per node, inflorescence axis elongating to 8–40 cm, with flowers in distinct whorls; pedicels 3–9 mm; calyx tube glabrous to sparsely strigillose ..... **Erythrina herbacea**

1. Young stems and inflorescence axis moderately to densely strigose-villous to villosulous-puberulent; stem prickles 4–9 mm long; rachis and petiolule without prickles; leaflet blades ovate to triangular, deltate, or depressed-ovate, barely if at all 3-lobed, apices not acuminate; flowers mostly borne singly, sometimes in fascicles of 2–3, inflorescence axis elongating to 5–13 cm, with flowers not separating into distinct whorls; pedicels 2–3(–5) mm; calyx tube strigose-villous to villosulous-puberulent ..... **Erythrina sierra**

ERYTHRINA NIGROROSEA (Krukoff & Barneby) Nesom, **comb. et stat. nov**. *Erythrina herbacea* subsp. *nigrorosea* Krukoff & Barneby, Phytologia 25: 6. 1972. **TYPE: MEXICO. Oaxaca**. Protologue: "Gulf slope of Isthmus of Tehuantepec." Label: Near Matias Romero, soon after a divide (Atlantic drainage), pink standards, small shrub with spines, 6 Mar 1970, *B.A. Krukoff 1970-83* (holotype: NY digital image!; isotype: F digital image!).

Shrubs or small trees 1.5–3 m, densely armed with stout, recurved prickles 3-6 mm long, stems and inflorescence axes glabrous to sparsely strigose. **Leaves**: petioles and petiolules often with prickles; petiolules 3–6 mm; leaflets ovate to triangular-ovate, deltate-ovate, or rhombic with broadly to narrowly acuminate apex, sometimes 3-lobed. **Flowers** borne singly or in fascicles of 2–3, inflorescence elongating to 5–12(–15) cm but mostly remaining relatively compact (proximal flowers deciduous, see Figs. 8 and 9), not separating into conspicuous whorls; pedicels 1–4(–5) mm. **Calyx** pinkish to dark red, reddish brown, or blackish, glabrous to sparsely strigose or strigillose with fine, minute hairs, tube 7–10 mm. **Corolla banner** 3–5 cm, pink to pinkish-red. **Fruits** subcylindric with shallow constrictions, 6–12 cm. **Seeds** 2–8, 10–12 mm long, orange-red to reddish brown.

These plants were identified as *Erythrina herbacea* (Krukoff 1939) and then *E. standleyana* (Krukoff 1971). Krukoff and Barneby (1972) recognized them to be distinct as *E. herbacea* subsp. *nigrorosea*, as they were still later also identified by Krukoff (1982). *Erythrina nigrorosea* differs from typical *E. herbacea* in its larger habit, pink flowers, more congested inflorescence, and its southern geography. *Erythrina standleyana* occurs in Belize, Guatemala, Campeche, Quintana Roo, Tabasco, and Yucatan — the plants are shrubs or trees (1–)3–5(–6) meters tall with unlobed, ovate to broadly ovate or ovate-acuminate leaves and a prominently elongating inflorescence.

The epithet 'nigrorosea' alluded to the calyx/corolla color contrast (the plants are "especially atractive because of [their] pale pink standard contrasting with a black calyx" (Krukoff & Barneby 1972, p. 7). The corolla color is relatively constant but a survey of herbarium collections indicates that the calyx color is more variable. David Neill made collections of *Erythrina nigrorosea* in the vicinity of Lerdo de Tejada, Veracruz, in January 1983, documenting variation in calyx and corolla color (*Neill 5389*, *5390*, *5392*, *5393*; LL, MO). His labels described the plants as multiple-stemmed shrubs 2–3 meters tall. Calyces varied from yellowish red to brownish red or red; banner and keels varied from pink to red or pink with a red apex. He noted the possibility of hybrid influence in *5389* and *5390* with *E. folkersii* Krukoff & Moldenke, which grew within 1 kilometer of the *E. nigrorosea* populations. Neill also made collections at the type locality (Oaxaca: 5 km N of Matias Romero, 14 Apr 1983, *Neill 5640*, LL, MO) — calyces there were reddish brown; corollas were pink — and in Chiapas (Mpio. Catazaja, *Neill* 5536, *5537*, *5538*, MO), where calyces were noted to be reddish brown to green and corollas pink to pale red and red.

Figure 10. *Erythrina nigrorosea*. Note the pink calyces (see comments in text regarding color variability). Photo by Randy Baldwin at a location near Aquismón, San Luis Potosi. Used by permission of San Marcos Growers.

Figure 11. *Erythrina nigrorosea* cultivated by Jeff Chemnick in Santa Barbara, California. Grown from seeds collected by Chemnick with Randy Baldwin at Aquismón, San Luis Potosi, same population as shown in Fig. 10. Photo by Randy Baldwin, 29 March 2016.

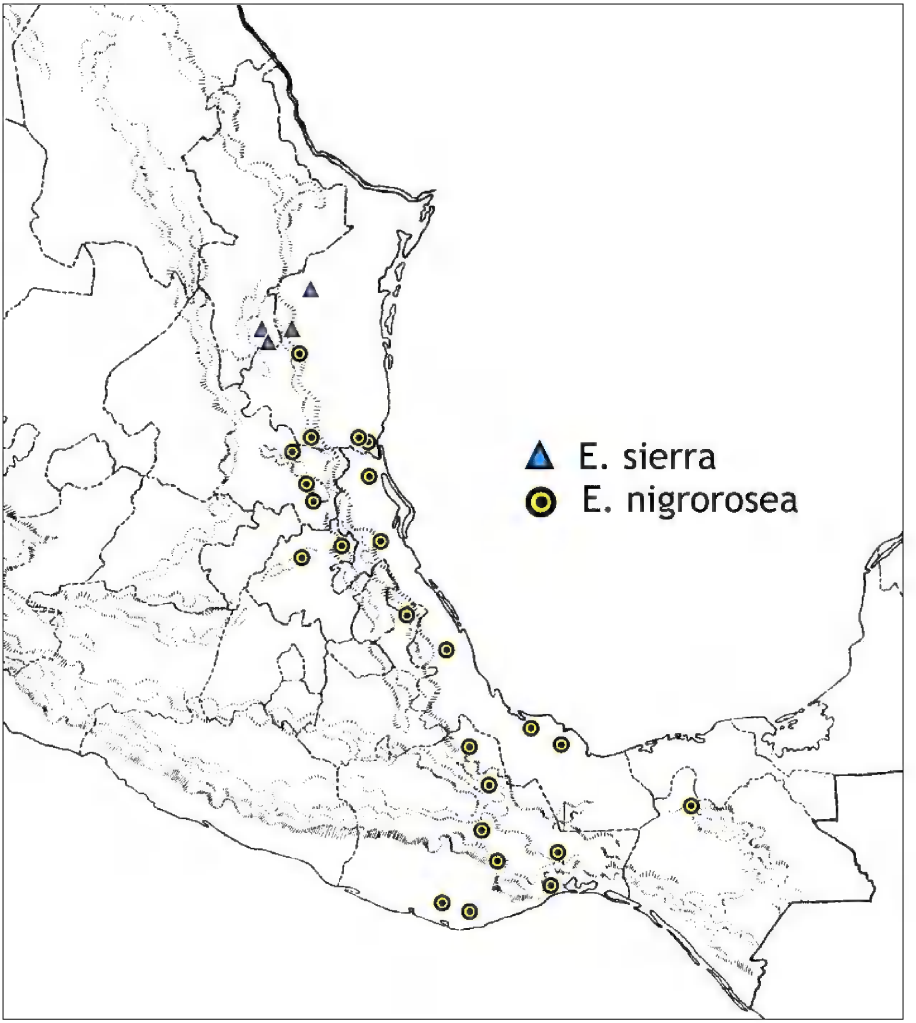

Figure 12. Distribution of *Erythrina sierra* and *E. nigrorosea*. Specimen citations for *E. sierra* are given in the text; localities for *E. nigrorosea* are from Krufoff (1971) and Krukoff and Barneby (1972) and from collections at MO, TEX-LL, and SMU-BRIT-VDB.

The ranges of *Erythrina nigrorosea* and *E. sierra* apparently closely approach each other in central Tamaulipas, but they are different in habitat. Collections examined of *E. nigrorosea* are these: Mpio. Victoria: ca. 6 mi S of Cd. Victoria along Rte. 70, open sun, 6 Apr 1961, *King 4509* (TEX!); vic. of Victoria, 320 m, 1 May-13 Jun 1907, *Palmer 544* (MO!). Krukoff (1971) cited (as *E. standleyana*) other collections from the vicinity of Cd. Victoria: *Runyon 972* (US); *Palmer 119* (US), and *Kenoyer & Crum 3315* (GH); these are presumed here to be *Erythrina nigrorosea*.

Figure 13. *Erythrina nigrorosea*. Photo by Randy Baldwin at a location near Aquismón, San Luis Potosi. Used by permission of San Marcos Growers.

Figure 14. *Erythrina nigrorosea* cultivated by Jeff Chemnick in Santa Barbara, California. Grown from seeds from Aquismón, San Luis Potosi, same population as in Fig. 11. Photo by Randy Baldwin, 29 March 2016.

Figure 15. *Erythrina nigrorosea*. Photo by Sally and Andy Wasowski, April 1986, cultivated in Texas (location otherwise unspecified). From the image collection of Lady Bird Johnson Wildflower Center's collection of plant images, NPIN Image Id: 22417, identified as *E. herbacea*.

ACKNOWLEDGEMENTS

I'm grateful to staff at MO, TEX-LL, BRIT-SMU for help while studying there and to Amy Buthod (OKL) for information on Oklahoma *Erythrina*, Barney Lipscomb (BRIT) for the digital scan of Catesby's illustration, Randy Baldwin of San Marcos Growers for information and photos of *E. nigrorosea*, and Mark Hutchinson of Spring Hill, Florida, for photos of *E. herbacea*.

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PODRANEA RICASOLIANA (BIGNONIACEAE) ADVENTIVE IN TEXAS

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ABSTRACT

Podranea ricasoliana is reported here as adventive to Texas, based upon a recent collection in Cameron County. The species is generally considered to be native to South Africa. The occurrence of the species in Texas probably originated from discarded garden waste of ornamental specimens, since the seeds of the species exhibit low fertility.

Podranea ricasoliana Sprague (Bignoniaceae) is commonly known as pink trumpet creeper, Port St. John's creeper, and Zimbabwe creeper. It is generally thought to be native to South Africa (Bailey 1949; Wunderlin 1998). However, many South African botanists, such as Malan and Notten (2002), suspect that this climber may not be indigenous to South Africa, apparently based upon historical perspective. All [African] sites where *Podranea ricasoliana* are found have ancient connections with slave traders, who frequented the eastern coast of Africa long before the 1600s, thus alluding to an earlier introduction. It has become such a widely grown garden plant in all of the warmer parts of the world that it may prove difficult to find its real origin. The species has also been recorded in India, the Philippines, New Caledonia, Bolivia, Mexico, Nicaragua, Panama, Columbia, Belize, Ecuador, and Jamaica (Hassler 2016) and Australia (Atlas of Living Australia 2016). Within territories of the USA, *P. ricasoliana* is known from Puerto Rico and the Virgin Islands (Acevedo-Rodriguez 2005). In the USA, it has been reported from Brevard, Dade, Everglades, Orange, Polk, Highlands, Seminole, and Volusia counties, Florida (Kartesz 2016; Wunderlin 2016). It is also cultivated and supposedly naturalized in Hawaii (Starr et al. 2004). Overall, *P. ricasoliana* thrives in warm climates but can survive in cooler conditions as well.

In Texas, the species is occasionally used as an ornamental, particularly in the Gulf Prairies and Marshes vegetation region (personal observations).

Cultivated specimens. **Texas**. McLennan Co.: Las Adaes [residence of the collector] on Big Mailbox Road, Robinson (Waco), Nov 2007, *W.C.Holmes 13924* (BAYLU). Nueces Co.: 600 Block of Park Avenue, Corpus Christi, 11 Oct 1974, *J.A.Bauml et al. 74-331* (TEX). [Both specimens are annotated as being cultivated. The Nueces County specimen information is from the Plant Resources Center, University of Texas Herbarium (2016)].

Continued field studies within Texas have resulted in the collection of a specimen of *Podranea ricasoliana* apparently naturalized in Cameron County. The species may now be reported as adventive to the state.

Voucher specimen. **Texas**. Cameron Co.: Valley Land Trust Preserve, 0.2 mi N of Texas Rte. 227 and Salida de Luna, W side of Texas Rte. 227, resaca (dried river channel), N 25° 57′ 16″, W 97° 25′ 49″, 8 Dec 2015, *Singhurst 21029* with Allen, Pons, and Rodriguez (BAYLU). Figure 1.

Figure 1. *Podranea ricasoliana* naturalized in Cameron County. Photo by Jason Singhurst.

Podranea ricasoliana is a vigorous woody evergreen climber or climbing shrub lacking tendrils. Its compound leaves are long-oval shaped and often are deep glossy-green. It has strong stems that may grow to 10 meters high. Flowers, which are borne in panicles, are pink, about 5 cm long, and trumpet-shaped. The tubes have 7–9 rose-red veins inside. Fruits (observed on *Holmes 10279*, BAYLU) from Ajijic, Mpio. Chapala, Jalisco, Mexico) are light brown, narrow, straight, flattened capsules up to 25 cm long. Seeds (not present on *Holmes 10279*) are brown, ovate, and flat and have large rectangular papery wings (arils). [Parts of the above description are from Malan and Notten (2002) and Bailey (1949).

Apparently seeds have low fertility, but the species can be propagated by cuttings or layering (Malan & Notten 2002). With its fast growth, appealing appearance, and durability during cooler seasons, *Podranea ricasoliana* is a good ornamental plant. Due to its worldwide usage in gardens, the species has been able to spread, apparently sprouting from pruning and discarded garden waste. Its rapid spread in optimal conditions causes many to consider it to be an invasive weed despite the fact that many of its seeds are infertile. Currently, this species is considered to be a weed in Australia, New Zealand, and Hawaii (Hassler 2016; Starr et al. 2016). *Podranea ricasoliana* probably has escaped to the wild in Texas from specimens brought in for horticultural reasons.

Podranea ricasoliana was documented in a Texas Ebony Resaca Forest (NatureServe 2016). These forests occur on deep, well-drained soils of the Rio [Río] Grande River delta along mesic resaca banks and low-lying areas formed by old river channels. These areas are not a component of the active river floodplain but may be subject to periodic inundation and drying. This evergreen subtropical plant community once occurred as dense forests with and larger subtropical trees. The remaining examples of the Resaca Forest in Texas are described as having no clear dominant. Larger tree species occurring at the Valley Land Trust Resaca Site were *Ebenopsis ebano* (*Pithecellobium ebano*), *Ehretia anacua*, and *Leucaena pulverulenta*. Other characteristic trees and shrubs included deciduous trees more characteristic of floodplain forests, such as *Celtis laevigata* var. *laevigata*, *Fraxinus berlandieriana*, *Prosopis glandulosa* var. *glandulosa* and *Sabal mexicana*. Characteristic tree and shrub species with subtropical affinities were *Celtis pallida*, *Malpighia glabra*, *Parkinsonia aculeata*, *Phaulothamnus spinescens*, *Sideroxylon celastrinum* (*Bumelia celastrina*), and *Zanthoxylum fagara*. Common shrubs were *Baccharis neglecta*, *Condalia hookeri*, and *Malvaviscus arboreus* var. *drummondii*. The ground layer and other vines were sparse because of shading but included *Cissus trifoliata*, *Eupatorium odoratum*, *Nekemias arborea*, *Panicum maximum*, *Rivina humilis*, and *Salvia coccinea*. The invasive *Schinus terebinthifolius* (Brazilian peppertree) was present along the waterline [edge] of this resaca site.

Etymology. The name *Podranea* is an anagram of *Pandorea* (Bignoniaceae), a closely related Australian genus in which *Podranea* was first described as *Pandorea ricasoliana* Baill. *Pandorea*, hence *Podranea*, is from the Greek *Pandora*. The specific epithet, *ricasoliana,* presumably alludes to the gardens of Baron Ricasoli in Italy (Bailey 1949).

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SCLERANTHUS ANNUUS (CARYOPHYLLACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Scleranthus annuus is here reported as naturalized in Van Zandt County of northeastern Texas, where it has formed relatively dense colonies. Establishment of the species in Texas is an expansion from many known localities in Oklahoma, Louisiana, and Arkansas.

Scleranthus annuus L. (Caryophyllaceae) is a native of Europe, Asia, and North Africa (Thieret & Rabeler 2005). It is known through much of the rest of the temperate world as an introduced species and common weed. It grows in many types of habitats and often occurs in disturbed sandy areas, roadsides, weedy areas, and lawns. Common names of the species are German knotgrass (Wunderlin 1998) and annual knawel (Thieret and Rabeler 2005).

We report *Scleranthus annuus* as new to the spontaneous flora of Texas, vouchered by the following specimen. **Texas**. Van Zandt Co.: 0.1 mi S of jct of Hwy 64 and Old Kaufman Rd, along the banks of the City of Canton Lake Dam at Cherry Creek Park, 10 Apr 2016, *S. Hill s.n.* (BAYLU). Figures 1, 2.

The *Scleranthus annuus* population in Van Zandt County consists of several hundreds of individuals on a frequently mowed dam on the edge of City of Canton Lake [a reservoir] within Cherry Creek Park. The plants occur on clay soil and densely carpet the area. Associated flora include *Soliva sessilis*, *Sherardia arvensis*, *Trifolium dubium*, *Houstonia pusilla*, *Oxalis stricta*, and *Galium aparine*.

Scleranthus annuus is mapped in Kartesz (2016) as occurring in the states bordering Texas (Arkansas, Oklahoma, and Louisiana) and its establishment in Texas is hardly unexpected. Records nearest to Van Zandt County are Marshall County, Oklahoma, approximately 160 km to the northwest, and Caddo Parish, Louisiana, about 190 km to the east. The species is also known from Vernon and Cameron parishes of southwest Louisiana, both bordering Texas.

The species is apparently absent from Coastal Plain of Arkansas (the southwest region of the state). With the exception of Manitoba, *Scleranthus annuus* is naturalized in the southern providences of Canada, south into the northwest USA (California, Idaho, Oregon, and Washington); and eastern USA west to Minnesota, Nebraska, Kansas and Oklahoma (not including Iowa) (Kartesz 2016). The species is widely naturalized across the world, including Mexico, Costa Rica, Ecuador, South Korea, Kenya, South Africa, and New Zealand (Thieret & Rabeler 2005).

Figure 1. *Scleranthus annuus*, Van Zandt Co., Texas. Photo by Sonnia Hill, 10 April 2016.

Figure 2. *Scleranthus annuus*, Van Zandt Co., Texas. Photo by Sonnia Hill, 10 April 2016.

The plants are annual or biennial with erect to prostrate stems 2–25 mm long. They typically flower from winter to fall. Leaves vary from 3–24 mm in length. The flowers are usually equal to or exceed the length of the subtending bracts. The hypanthium is strongly 10-ribbed in fruit and 1.2–2 mm wide. Sepals are spreading to erect in fruit and do not overlap. Fruits range from 3.2–5 mm wide, which includes the sepals.

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ASPARAGUS AETHIOPICUS (LILACEAE) NATURALIZED IN TEXAS

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ABSTRACT

Asparagus aethiopicus is reported here as naturalized in Aransas and Nueces Counties of the Gulf Coast Prairies and Marshes Ecoregion in the Coastal Bend (mid-coast) of Texas, where it has formed colonies in the understory of Coastal Live Oak-Redbay Woodlands.

Asparagus aethiopicus L. (asparagus fern, foxtail fern) is a native of to the Cape Provinces and the northern provinces of South Africa. It is considered invasive in Australia and in the USA, where naturalized in Alabama, California, Florida, Georgia, Missouri, and Virginia (Kartesz 2016). It has been declared a Category I invasive plant in Florida (University of Florida UF/IFAS 2016). Plants can be found spreading along roadsides and invading secondary forest systems. When colonies are formed, native vegetation can be displaced and native species prevented from reestablishing (University of Florida UF/IFAS 2016).

We report *Asparagus aethiopicus* as new to the spontaneous flora of Texas, vouchered by the following collections in Aransas and Nueces counties of the Gulf Coast Prairies and Marshes Ecoregion.

Texas. Aransas Co.: 0.1 mi N. of jct. of Bay Rd and N. Fulton Beach Rd on N. Fulton Beach Rd, W side of N. Fulton Beach Rd., in understory of Coastal Live Oak-Redbay Woodland, 7 Mar 2016, *Singhurst 21038* (BAYLU); 0.1 mi. E of jct. of Hwy 35 and N Fulton Beach Rd on N Fulton Beach Rd, N side of N Fulton Beach Rd., in understory of Coastal Live Oak-Redbay Woodland, 7 Mar 2016, *Singhurst 21039* (BAYLU). Nueces Co.: 0.05 mi NW of the jct. of Park Rd 22 and Aquarium, near edge of Packery Channel as it merges with the Upper Laguna Madre, in Seashore Bluestem Coastal Prairie, 8 Mar 2016, *Holmes*, *Mink*, and *Singhurst 16643* (BAYLU). Figures 1, 2.

The *Asparagus aethiopicus* populations in Aransas County consist of several colonies ranging from 1 x 1 m to 5 x 7 m growing in the understory of Coastal Live Oak (*Quercus virginiana*) and Red Bay (*Persea borbonia*) Woodlands. The associated woody flora includes *Ilex vomitoria, Erythrina herbacea, Callicarpa americana, Malvaviscus arboreus* var. *drummondii*, and *Smilax bona-nox*. The associated herbaceous species include *Andropogon glomeratus, Baccharis halimifolia, Conoclinium betonicifolium, Helianthus argophyllus, Hydrocotyle bonariensis, Lycium carolinianum, Maurandella antirrhiniflora*, and *Schoenoplectus pungens*. The Nueces County population consisted of a small 1 x

1 m patch growing in a Seashore Bluestem (*Schizachyrium littorale*) coastal prairie. Other associated herbaceous species include *Eustachys petraea, Fimbristylis caroliniana, Flaveria brownii, Hydrocotyle bonariensis, Iva texensis, Lycium carolinianum, Schoenoplectus pungens, Sisyrinchium* sp., and *Sporobolus virginicus*.

Figure 1. *Asparagus aethiopicus*, Aransas Co., Texas. Photo by Jason Singhurst, 7 March 2016.

Plants of *Asparagus aethiopicus* are slightly woody, evergreen, with upright or trailing branches. They can grow up to 2 feet in height and 6 feet in length. Branchlets are needle-like and clustered in nodes; tiny spines are borne in the axes of the branches. Leaves are fine and needle-like. The flowers are white or pale pink and very fragrant, small and hardly noticeable. Flowering lasts for roughly two weeks during the summer. The fruits are bright red in color and contain 3 seeds per fruit. Birds are highly attracted to the fruit and aid in the dispersal of asparagus fern (University of Florida 2016).

Figure 2. *Asparagus aethiopicus*, Aransas Co., Texas. Photo by Jason Singhurst, 7 March 2016.

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TYPIFICATION OF THREE LINNAEAN NAMES IN *PASSIFLORA* (PASSIFLORACEAE)

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ABSTRACT

Lectotypes and epitypes are designated for three previously untypified Linnaean names: *Passiflora rubra* L., *P. capsularis* L., and *P. rotundifolia* L.

Linnaeus described 24 species in the genus *Passiflora* (1753), of which 11 have been effectively typified. Preparation for publication of a monographic thesis study by Boza (2010) in part of the genus, sect. *Xerogona* (Raf.) Killip, requires the clarification and typification of two similar and closely related species, *P. capsularis* L. and *P. rubra* L. These two species were first described from the Caribbean islands by various pre-Linnean authors, and the recent monographic study has suggested that in that area there are indeed two distinct biological entities, considered by Boza to be two species. One has a very pale red, or white and red flower, the other an all-white or white and cream flower and a more acutely pointed fruit (Boza 2010). Historically the names *P. capsularis* and *P. rubra* have been applied to both these very similar species, with much confusion in the literature of the 17th through 19th century in application of the names and polynomial synonyms of earlier authors (Lamarck 1789: 35–36; Killip 1938: 217, 221).

Typification of a species not studied by Boza, *Passiflora rotundifolia* L., is included here because its story and original materials are nearly the same as *P. capsularis* and were examined concurrently.

All original elements in Linnaeus' protologues of these species were studied, and although original material in the form of icons was found for each of the three species treated here, no specimens could be located that were seen by Linnaeus prior to 1753. Therefore, lectotypes were chosen from the illustrations available to Linnaeus as original material (McNeill et al. 2012), and fortunately, those were accompanied by detailed documentation of provenance. The lecto-typifications given below preserve the common usage of the names in modern monographs and floras over the last century (e.g., Masters 1872; Killip 1938; Estrada & Rodríguez 2009). Epitypes were chosen from among specimens originating from the specific geographical area associated with the original material, which is more specific than the general statements of habitat given by Linnaeus in the respective protologues.

TAXONOMIC TREATMENT

Passiflora rubra L., Sp. Pl. 2: 956. 1 May 1753. ≡ *Granadilla rubra* (L.) Moech, Suppl. Meth. 15. 1802. ≡ *Decaloba rubra* (L.) M. Roem., Fam. Nat. Syn. Monogr. 2:153. 1846.

LECTOTYPE (designated here): [icon] An illustration, Plumier, Descr. Pl. Amer., t. 83. *Clematitis indica flore clavato suaverubente, fructu hexagono, coccineo, folio bicorni.* 1693.

EPITYPE (designated here): West Indies. Windward Islands: Dominica. Carib trail from Salybia to Hatton Garden, promontory overlooking Salybia church, 30 Apr 1940, *W.H. Hodge 3284* (NY [barcode] 01921803, image seen).

The only material associated with this name in the LINN herbarium (Herb. Linn. 1070.8) was collected by Patrick Browne and was not received by Linnaeus until 1758 (Stearn 1957: 122; Jarvis 2007; Linnaean Plant Name Typification Project), so it cannot be original material for the name. The type must therefore be sought among the cited elements and original material.

Linnaeus describes *Passiflora rubra* in *Species Plantarum* as "*Passiflora foliis bilobis basi emarginatus petiolatis*" and first cites his *Amoen. acad. 1. p. 222. [t. 10] f. 9* (Linnaeus 1745, 1749). The simple illustration of a single leaf found here in Hallman's dissertation can be considered original material, but we find it to be too simple to adequately fix precise taxonomic application of the name.

The next element of the protologue includes additional original material in the form of the plate t. 83 published by Plumier in 1693 in his *Description des plantes de l'Amérique* of the species "*Clematitis indica flore clavato suaverubente, fructu hexagono, coccineo, folio bicorni.*" The plate is of good quality and shows the diagnostic shape of the fruit and leaves (Figure 1). We therefore choose t. 83 to be the lectotype. Plumier (1693: 68–69) distinguished this species from the closely related species [*P. capsularis*] by stems smaller, rounder and dark; flowers tinged light red with corona part purplish, part white; petals white tinged with red, or just white; and fruits a little shorter and not as elongated at the ends.

Other elements and references in the protologue are compatible with the first elements and contain no original material in the form of icons. Linnaeus gave the provenance of *Passiflora rubra* as "Jamaica, Dominica, Martinica, Cayenne." Plumier (1693: 69) stated that the species illustrated by the lectotype plate is from Martinique, where it is abundant. Britton (1917) correctly surmised the type locality to be Martinique but cited no specimen.

Killip (1938: 219), Bornstein in Howard (1989: 382), and Holm-Nielsen et al. (1988: 48) all wrongly indicated the type or lectotype to be the Browne collection Herb. Linn. 1070.8 (LINN), which is not an original element.

Modern photographs of this species from different Caribbean islands show notable variation in floral characteristics such as orientation, color, and number of the outer coronal filaments, so in choosing an epitype to assist in application of the name, we considered provenance of the lectotype to be important. The Browne collection, Herb. Linn. 1070.8, although fertile, has only two flowers that are pressed closed, and is from Jamaica. Unable to locate adequate fertile specimens from Martinique, we have chosen a well-prepared modern collection with buds, flower, and immature fruits from the neighboring island of Dominica.

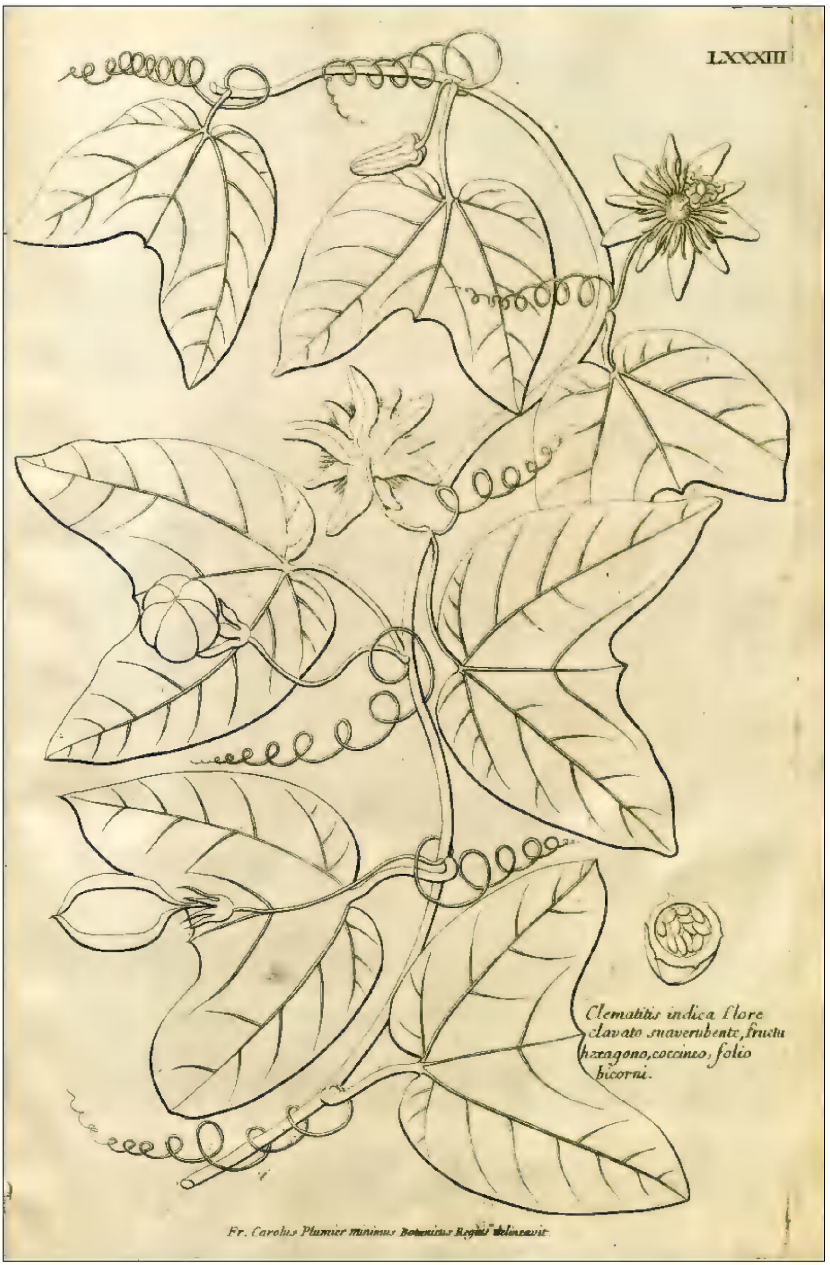
LXXXIII
Clematitis indica flore clavato suaverubente, fructu hexagono, coccineo, folio bicorni.
Fr. Carolus Plumier Minimus Botanicus Regius delineavit

Figure 1. Tabula 83 from Plumier's Description des plantes de l'Amérique, 1693, *Passiflora rubra* L.

Passiflora capsularis L., Sp. Pl. 2: 957. 1 May 1753. ≡ *Granadilla capsularis* (L.) Medik., Malvenfam. 96. 1787. ≡ *Xerogona biloba* Raf., Fl. Tellur. 4: 103. 1838, nom. illegit-superfl. ≡ *Decaloba capsularis* (L.) M. Roem., Fam. Nat. Syn. Monogr. 2: 154. 1846.

LECTOTYPE (designated here): [icon] the engraved illustration, fig. 1, on the left side of the frontispiece title page of Barrelier, Pl. Galliam Hisp. Ital. Obs. Icon. Æneis Exhib. 1714.

EPITYPE (designated here): Haiti. [Ouest:] Vic. Pétionville, 350 m, 15–28 Jun 1920, *E.C. Leonard 4882* (US-1077426, barcode 00770192, image seen). Isoepitypes: B (not seen), NY (not seen).

There is no material associated with this name in the LINN herbarium (Jarvis 2007, http://www.nhm.ac.uk/research-curation/research/projects/linnaean-typification/index.html) so the type must therefore be sought among the cited elements and original material. The protologue in *Species Plantarum* for *Passiflora capsularis* is short: Linnaeus described it as "*Passiflora foliis bilobis cordatis oblongis petiolatis*" then quoted "*Granadilla fructu rubente, folio bicorni*" referencing "*Plum. spec. 6*" and "*Barr. obs. praef. 1. titul. f. 1.*" He gave the location as "*Habitat in* Gallia *aequinoctiali*".

The first reference is to the polynomial on page 6 of Plumier's *Catalogus Plantarum Americanum* which appeared at the end of his *Nova Plantarum Americanarum Genera* (1703). The second is to the frontispiece title page of Barrelier's work (1714) completed and edited posthumously by Antoine de Jussieu, and to the associated caption/ description in the preface. Two of Plumier's previously unpublished drawings are redrawn as embellishments to the left and right sides of the frontispiece of that book, and the two species are described a few pages later in the *Admonitio* foreword, taken from Plumier's manuscript notes. The foreword (translated) by the editor Ant. Jussieu begins:

> There are some things, gentle reader, of which I want to caution you about this edition. First I have presented in the frontispiece, which was to be redolent of everything botanical, two Granadilla species selected from Plumier's collected manuscripts and nowhere else depicted. I thought that no ornament on the previous page would be more welcome to you than this, which should please the mind as well as the eyes by its novelty and that you will recognize more completely from the following descriptions of these plants.

Plumier's original drawings and descriptions would have been available to Jussieu at the Bibliothèque nationale in Paris, and apparently were made available to the engraver of the frontispiece. The drawing on the left is labeled "1" and is listed in the foreword notes as "I. *Granadilla fructu rubente, folio bicorni.*" This illustration shows the diagnostic elongated capsular fruits and bilobed leaves of *P. capsularis* (our Figure 2).

Plumier had discerned and written about this species several years earlier in a discussion of another similar species, but had not given it a polynomial (1693). In that discussion about what has since been named *P. rubra* L. (see above under that species), Plumier stated that there was another very similar species that differed by having an almost totally white flower, a more triangular stem, with a more elongate fruit pointed at both ends, and was found at the "*1'Isle S. Domingue, au quartier de Leogane vers une terre nommée Marsenou, appartenante à feu M. Cussi-Tarin, pour lors Gouverneur de ladite Isle*" (1693: 68–69). Plumier published the polynomial in 1703, page 6. The caption in the preface of Barrelier's work retains that polynomial and expands greatly on the description and diagnosis of the species; the locality is again given as "Leoganae in Insulâ Sandominicanâ." Léogâne is in what is now Haiti, about 30 km west of Port-au-Prince.

The drawing after which these illustrations in Barrelier (1714) were modeled would be published several decades later by Burman in his *Plantarum americanarum* (*Pl. Amer.*), fascicle 6, t. 138 (see Plumier 1755 in bibliography). For the preparation of the *Pl. Amer.*, Burman used a set of

tracings of Plumier's original drawings made by Claude Aubriet in 1733, the "Gronigen (University Library) set" (Stafleu & Cowen 1983). This set was seen by Linnaeus during his stay in Holland (Stafleu & Cowen 1983) and can be considered original material for the typification of Linnaean species (Jarvis 2007 and pers. comm.). However, in this case, Linnaeus undoubtedly saw the depictions and detailed descriptions of these same drawings in Barrelier (1714) long before he went to Holland. Therefore, the icon in Barrelier (see Fig. 1, here) is chosen as the lectotype of *Passiflora capsularis* over the other original material.

Deginani (2001: 66) indicated unspecified, unseen material in LINN as the holotype. However, there is no material associated with this name now in LINN.

Holm-Nielsen et al. (1988: 46) listed the type as "not seen" and from "French Guiana," their cited location being their interpretation of the habitat from the protologue. Linnaeus' statement of provenance for *Passiflora capsularis*, "Gallia *aequinoctiali*," is slightly misleading because the origin is clearly stated in the preface of Barrelier (1714), as well as in Plumier 1693, to be the "island" of Saint-Domingue, the western French-controlled portion of Hispaniola. Perhaps he was influenced by the appearance of this species on the title page of the book, *Pl. Galliam.*

We have chosen as epitype a specimen with a well-pressed white flower, buds, and immature fruit collected very near the original collection locality.

Passiflora rotundifolia L., Sp. Pl. 2: 957. 1 May 1753. ≡ *Decaloba rotundifolia* (L.) M. Roem., Fam. Nat. Syn. Monogr. 2: 159. 1846.

LECTOTYPE (designated here): [icon] the engraved illustration, fig. 2, on the right side of the frontispiece title page of Barrelier, Pl. Galliam Hisp. Ital. Obs. Icon. Æneis Exhib. 1714.

EPITYPE (designated here): West Indies: Martinique [without further locality], Nov 1867, *L. Hahn 177* (K [herb. Hooker]). Isoepitypes: BM [barcode BM000915306], P [barcode P00562590].

Passiflora rotundifolia had its origin in the reference "*Granadilla folio Hederaceo, flore albo, fructo globoso, villoso* Plum." in a list of granadillas published by Tournefort (1700), with the polynomial repeated in Plumier's 1703 catalog. There is no material associated with this name in the LINN herbarium. The protologue for *P. rotundifolia* is short: Linnaeus described it as "*Passiflora foliis subtrilobis obtusis subrotundis*" then quoted "*Granadilla folio hederaceo, flore albo, fructo globoso villoso*" citing "*Plum. spec. 6*" and "*Barr. obs. praef. 1. titul. f. 2.*" He gave the location as "*Habitat in* America *australiori.*"

The first reference is to the polynomial on page 6 of Plumier's *Catalogus Plantarum Americanum* which appeared at the end of his *Nova Plantarum Americanarum Genera* (1703). The second is to the frontispiece title page of Barrelier (1714), to the icon on the right side, of the plant labeled "2", and to the associated description in the preface, although in the preface this species is listed as "II". Linnaeus' citation of "praef. 1" would seem to be a minor error of citation. The icon (see our Figure 2) is a rendition of an unpublished drawing by Plumier, and the species is described a few pages later in the *Admonitio* foreword. See under *Passiflora capsularis* above for a complete discussion of the context and authorship of Barrelier's 1714 opus.

The engraving on the right labeled "2" shows the diagnostic pubescent ovary and leaf shape of *P. rotundifolia*, and is captioned in the foreword notes as "II. *Granadilla folio hederaceo, flore albo, fructo globoso villoso* Plum. Cat. [1703] & Inst. R. Herb. 241 [Tournefort 1700: 241]." The notes give a long description and diagnosis of the species; the locality is given as "*circa montem vulgò dictum* le morne de la Calebasse *in insulâ Martinicanâ*," a name used for that mountain peak even until today.

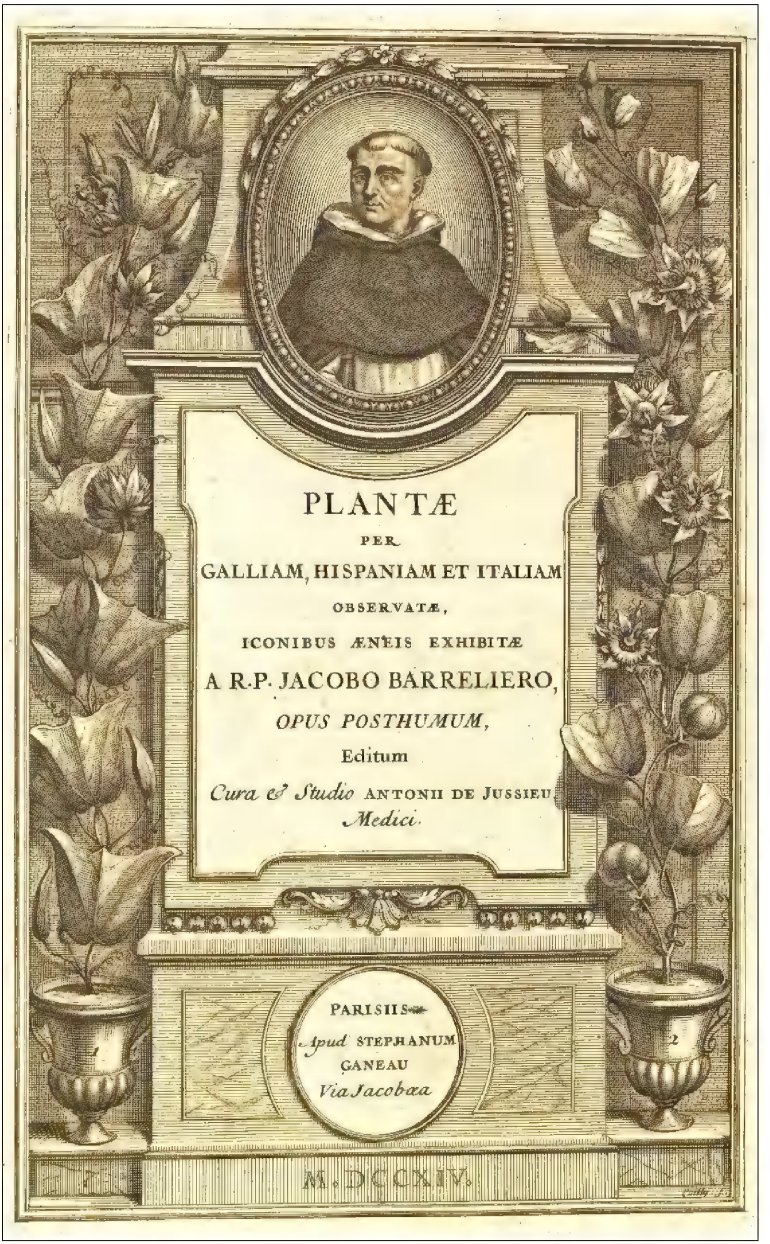

Figure 2. The frontispiece title page of Barrelier, Pl. Galliam Hisp. Ital. Obs. Icon. Æneis Exhib. 1714. *Passiflora capsularis* L. is shown on the left, *P. rotundifolia* L. on the right.

Additional original material, as in the case of *Passiflora capsularis*, can be found in Burman (1755 [1757], see Plumier) in his *Plantarum americanarum* (*Pl. Amer.*), fascicle 6, t. 138, f. 2, *"Passiflora foliis sub-trilobus obtusis."* But again, as in the case argued above, Linnaeus undoubtedly saw the depictions and detailed descriptions of the drawings in Barrelier (1714) long before he saw the tracings upon which Burmann based his book. Therefore, the icon in Barrelier (see Fig. 1, here) is chosen as the lectotype of *P. rotundifolia* over the other original material.

Linnaeus' statement of provenance for this species as "America *australiori*" is inaccurate because it is clearly stated in the preface of Barrielier (1714) to be the island of Martinique.

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PUNICA GRANATUM (LYTHRACEAE) REAFFIRMED AS A COMPONENT OF THE ARKANSAS FLORA

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ABSTRACT

A recent occurrence of *Punica granatum* L. outside of cultivation is documented in the Arkansas flora. This record represents only the third known occurrence of the genus *Punica* outside of cultivation in the state, and the only one for over a decade. *Punica granatum* was first documented for Arkansas by Peck in 2003, based on specimens from Little River and Pulaski counties; however, *P. granatum* was subsequently not included in the 2006 *Checklist of the Vascular Plants of Arkansas* or the 2013 *Atlas of the Vascular Plants of Arkansas*. This paper serves to reaffirm the presence of *P. granatum* in the Arkansas flora. In 2015, one spontaneous plant of *P. granatum* was observed growing at the edge of a storm drain along a street in a residential area of Arkadelphia in Clark County. Photographs of the spontaneous plant in habitat, along with plants of the species, are provided.

Punica granatum L. is a large, thorny, deciduous shrub or small tree to 5 or 6 meters tall that is native to Europe and Asia (Bailey & Bailey 1976; Krüssmann 1978; Qin & Graham 2007; Fig. 1). This species is the pomegranate of commerce, and it is frequently cultivated in warm regions as an ornamental for its attractive flowers and foliage and for its edible fruits (Bailey & Bailey 1976); it has been cultivated in the Middle East for millennia. The edible, juicy covering surrounding individual seeds is actually a portion (sarcotesta) of the seed coat (Qin & Graham 2007). Although taxonomic placement within the Lythraceae is strongly supported (Graham et al. 2011), traditionally *P. granatum* has been separated into its own family, the monogeneric Punicaceae (Rana et al. 2010).

A dwarf variety of *Punica granatum*, often referred to as the cultivar 'Nana'—*P. granatum* L. var. *nana* (L.) Pers., also is sometimes cultivated (Bailey & Bailey 1976; Krüssmann 1978). It is similar to the species but has smaller leaves, flowers, and fruits and reaches a maximum size of only about 2 meters (Bailey & Bailey 1976; Krüssmann 1978).

Punica granatum is regularly cultivated in Arkansas. Some plants readily produce fruits, whereas others do not; this discrepancy may be owed to the fact that some cultivars of *P. granatum* apparently require cross–pollination for successful fruit set. The growing season in southern Arkansas is generally long enough for fruits to mature and ripen. The fruits are edible and similar in form and quality to commercially available pomegranates, and in at least some instances the seeds are viable (Serviss, unpublished data). Plants also are easy to cultivate, long–persistent subsequent to such practices, and may increase vegetatively via root suckers once established.

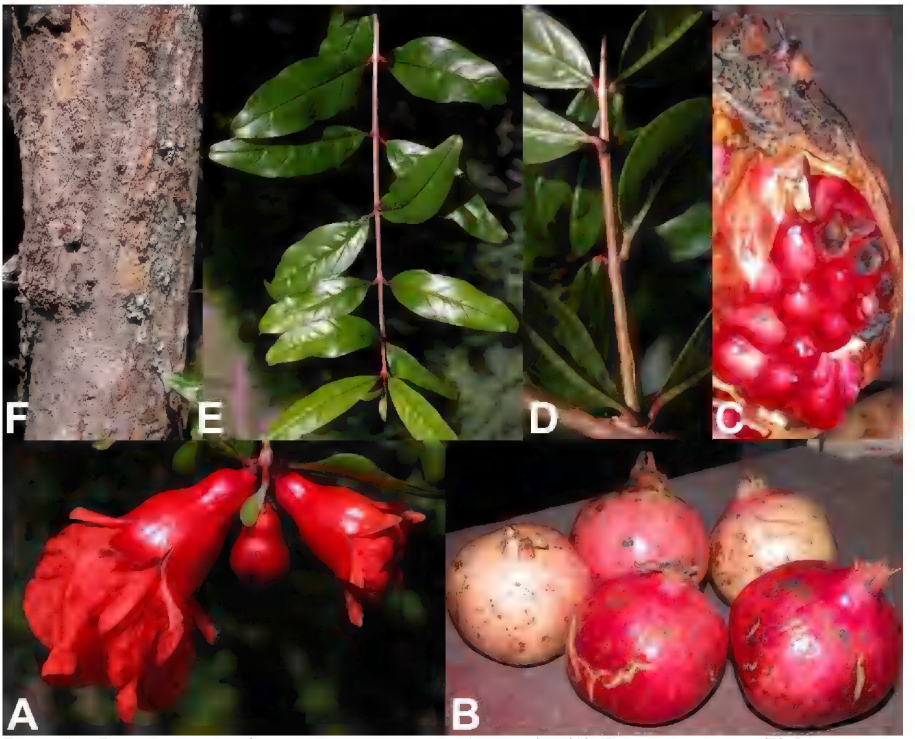

Figure 1. *Punica granatum* (from cultivated plants in Arkansas). (A) Flowers and bud. (B) Mature fruits showing some of the range of color variation that may be encountered. (C) Seeds showing sarcotestas. (D) Thorn. (E) Leaves and stem; notice the conspicuous red-colored petioles. (F) Older bark.

Based on these qualities, the presence of spontaneous plants of *Punica granatum* in Arkansas is not surprising. *Punica granatum* has been reported previously as a waif and/or a component of the naturalized floras of a number of southern states, including several parishes in adjacent Louisiana (Thomas & Allen 1998; Kartesz 2015; Weakley 2015; USDA, NRCS 2016).

Punica granatum was first documented for the Arkansas flora by Peck (2003), based on specimens of spontaneous/naturalized plants from Little River and Pulaski counties; however, the species was subsequently not included in the 2006 *Checklist of the Vascular Plants of Arkansas*, nor the 2013 *Atlas of the Vascular Plants of Arkansas* (Arkansas Vascular Flora Committee 2006; Gentry et al. 2013). Furthermore, to our knowledge, naturalized *P. granatum* has not been documented in Arkansas for over a decade. Our record represents only the third occurrence of the genus *Punica* outside of cultivation in the state and reaffirms the presence of *P. granatum* as a component of the state's flora.

In 2015, one spontaneous plant of *Punica granatum* was observed growing at the edge of the intake of a storm drain along a street in a residential area of Arkadelphia in Clark County (Figs. 2–3). No cultivated plants of *P. granatum* were observed in the immediate vicinity of the spontaneous

individual; however, a large, reproductive–age individual of *P. granatum* is cultivated about one block south of the site. Based on a conversation with one of the residents, the street where the spontaneous *P. granatum* plant is located periodically floods, with water sometimes rising over the curb and flooding lawns. It is plausible that storm water could have transported fruits and/or seeds from the cultivated *P. granatum* plant, or perhaps seeds from fruit discards, to the drain. Fruits or seeds could have become trapped at the opening of the drain, where a space is present between the street and the curb, and subsequently given rise to the spontaneous *P. granatum* plant. Of course, the origin of the spontaneous plant is unknown, but it is clearly evident that it was neither planted nor produced as a root sucker from a larger plant. Based on its frequency of cultivation and ability to produce viable seed, *P. granatum* should be expected elsewhere in Arkansas outside of cultivation.

In the Arkansas flora, it is possible with sterile material to confuse *Punica granatum* with *Pyracantha koidzumii* (Formosa firethorn) and smaller specimens of *Sideroxylon lanuginosum* (gum bumelia); however, *P. granatum* may easily be distinguished from both species by its glabrous foliage, petioles that are typically red in color, large (ca. 3–6 cm long by 2–4 cm wide, sometimes wider in forms with doubled flowers), solitary or 2–5–clustered, red to orange–red–colored flowers with thick, coriaceous calyces, and large (ca. 5–13 cm in diameter), solitary, yellow, yellowish–pink, pink, or red–colored fruits. Both *S. lanuginosum* and *P. koidzumii* (at least on new growth) have densely pubescent foliage, particularly the stems and undersurfaces of the leaves, and small, white to off–white–colored flowers that are densely clustered in the inflorescences. In addition, the fruits of both species are considerably smaller than those of *P. granatum*, and *S. lanuginosum* has purplish–black to black–colored fruits when mature.

Figure 2. Spontaneous plant of *P. granatum* in Clark County. (A) Close–up of plant showing leaves, stems, and new growth. (B) Plant and habit.

Figure 3. Distance view of the spontaneous plant of *Punica granatum* in Clark County showing size and position of plant relative to storm drain and street.

Voucher specimen: **Arkansas.** Clark Co.: One spontaneous plant growing in crack at edge of street at opening of storm drain, intersection of Henderson Street and 13th Street, Arkadelphia, 21 Oct 2015, *Serviss 8204* (HEND).

ACKNOWLEDGEMENTS

We are grateful to the Henderson State University Biology Department for supporting this work.

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REDISCOVERY OF *ELEOCHARIS OBTUSETRIGONA* (CYPERACEAE) IN TEXAS

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ABSTRACT

Eleocharis obtusetrigona (Lindl. & Nees) Steud. has been rediscovered in the Lower Rio Grande Valley of Texas (in Willacy Co.). Apparently decreasing in abundance and extent in the northern extent of its range, it is proposed here for G3/S1 conservation status.

Eleocharis obtusetrigona (Lindl. & Nees) Steud ranges continuously from South America (with a disjunct occurrence in the Galapagos Islands) through Central America and Mexico, into the Texas Lower Rio Grande Valley (Rosen & Hatch 2006). However, Texas collections of *E. obtusetrigona* are few (four sites in Cameron County and one in Kenedy County) and historic in that the most recent was made in 1959. Field work in 2004 by the first author led to the disappointing conclusion that it was probably extirpated at the historic collection sites due to drainage of wetlands for development and agriculture. Recent collecting in the Texas Lower Rio Grande Valley led to the rediscovery of *Eleocharis obtusetrigona* at a new site and new county.

Texas. Willacy Co.: E roadside Hwy 77, ca. 1 mi N of Yturria Station and 1 mi S of the Kenedy Co. line; locally rare in shallow water of seasonal freshwater pond with *Callitriche terrestris*, *Eleocharis quadrangulata*, *E. macrostachya*, *Rumex crispus*, *Utricularia gibba*, and *Echinodorus cordifolius*, 21 Nov 2015, *Richardson & King 4592* (RUNYON, TEX; Fig. 1).

Eleocharis obtusetrigona belongs to subg. *Limnochloa*, a group of over 35 species worldwide, differing from other *Eleocharis* in that they are emergent and robust wetland plants with cartilaginous floral scales and culms that are usually as thick as the cylindrical spikelets. Other members of subg. *Limnochloa* in the Texas Lower Rio Grande Valley include *E. cellulosa* Torr., *E. interstincta* (Vahl) Roem. & Schult., and *E. quadrangulata* (Michx.) Roem. & Schult. The following key distinguishes between them.

Key for identification of members of *Eleocharis* subg. *Limnochloa* in the Texas Lower Rio Grande Valley

1. Culms hollow with conspicuous complete transverse septa ..... **Eleocharis interstincta**
1. Culms internally spongy with incomplete transverse septa.
   2. Floral scales with many fine cellular-lineate veins (raised veins not clearly discernable at 20×); achene apex gradually narrowed into a stout spongy region of the same texture and color as the achene; perianth bristles usually smooth or rarely retrorsely spinulose ..... **Eleocharis cellulosa**
   2. Floral scales coarsely many veined (raised veins clearly discernible at 20×); achene apex markedly constricted to a short neck, neck sometimes obscured by the style base; perianth bristles finely to coarsely retrorsely spinulose.

3. Culms +- terete or distally obscurely 3-5-angled; achenes with ca. 15 longitudinal rows of epidermal cells (most appear transversely reniform at 40×) ..... **Eleocharis obtusetrigona**
3. Culms sharply quadrangular, never terete or distally obscurely 3-5-angled; achenes with ca. 22 longitudinal rows of transversely oblong epidermal cells ..... **Eleocharis quadrangulata**

UNIVERSITY OF TEXAS HERBARIUM
TEX
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Eleocharis obtusetrigona (Lindl. & Nees) Steud.
det. D.J. Rosen 2016
HERBARIUM
THE UNIVERSITY OF TEXAS AT BROWNSVILLE
BROWNSVILLE, TEXAS
Scientific Name: Eleocharis obtusetrigona
Location: Texas. Willacy County. 1Hwy 77 northbound, 1 mile south of Kennedy Co. Line
Comments (Ecology): Temporary pond on roadside
Collector/Number: Alfred Richardson, Ken King 4592
Date: 21 November 2015
4592

Figure 1. *Eleocharis obtusetrigona*. *Richardson & King 4592* (TEX).

Eleocharis obtusetrigona is common in South America, especially in Brazil where it is often dominant in large freshwater wetlands (Rafael Trevisan, pers. comm.). Although its abundance in Central America is unknown, populations of *E. obtusetrigona* were difficult to find during field work by the first author in Mexico (Veracruz). Some historic collection sites in Mexico have been destroyed (Socorro Gonzalez, pers. comm.). Though now rediscovered at the northern extent of its range, *E. obtusetrigona* is possibly still rare in the Texas Lower Rio Grande Valley. The population at the newly discovered site in Willacy County is small, and plants were not seen in other suitable habitats nearby. Until populations are discovered on public lands or protected sites, its persistence is not assured given the likely continued loss of wetlands. We suggest that it is of conservation concern in Texas and recommend a listing of G3/S1 as defined by Poole et al. (2008). We also encourage *E. obtusetrigona* be considered for freshwater wetland restoration projects throughout its historic Texas range.

ACKNOWLEDGEMENTS

We thank George Yatskievych for preparing Figure 1.

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ALYSICARPUS OVALIFOLIUS AND *ALYSICARPUS VAGINALIS* (FABACEAE) IN ALABAMA

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ABSTRACT

There is confusion in the literature about the occurrence of *Alysicarpus ovalifolius* and *Alysicarpus vaginalis* in Alabama. After a review of the literature and a detailed study of all collections from the state, it was determined that both taxa occur in southern counties of Alabama.

Alysicarpus Necker ex Desv. consists of approximately 25 species native to the Old World tropics (Isely 1990). Three of these, *Alysicarpus ovalifolius* (Schumach. & Thonn.) J. Leónard, *A. rugosus* (Willd.) DC., and *A. vaginalis* (L.) DC. have been introduced into the USA (USDA, NRCS 2016). Two of these taxa, *A. ovalifolius* and *A. vaginalis* have been reported from Alabama (Kral et al. 2011; Keener et al. 2016).

The PLANTS Database (USDA, NRCS 2016) recognizes *Alysicarpus ovalifolius* as occurring in Florida only, while *A. vaginalis* occurs in all Atlantic and Gulf coastal states from Virginia to Texas, with the exception of South Carolina. Kartesz (2016) reports the opposite; *A. ovalifolius* from Florida only and *A. vaginalis* from the coastal states listed above. The Flora of the Southern and Mid-Atlantic States (Weakley 2015) includes only *A. ovalifolius* but notes it is possible that *A. vaginalis* is represented in this area as well. Part of the confusion is likely because Isely (1990) recognized *A. vaginalis* but noted that material in the USA shares features of both *A. vaginalis* and *A. ovalifolius*.

In the Annotated Checklist of the Vascular Plants of Alabama (Kral et al. 2011), only *Alysicarpus ovalifolius* is listed as occurring in Alabama. However, the Alabama Plant Atlas (Kenner et al. 2016) recognizes only *A. vaginalis* in Alabama. The report from Kral et al. (2011) is based on collections from Baldwin and Conecuh counties. The report from Kenner et al. (2016) is based on the same two collections, plus additional collections from Pike and Mobile counties. Kartesz (2015) recognizes only *A. ovalifolius* in Alabama and reports it from Baldwin, Conecuh, and Mobile counties.

MATERIALS AND METHODS

Identification and geographical data used to determine the county-level distribution maps were compiled entirely from herbarium specimens analyzed during this study. These specimens are deposited in the following herbaria: Freeman Herbarium (AUA), Illinois Natural History Survey (ILLS), Michael I. Cousens Herbarium (UWFP), Troy University Herbarium (TROY), University of South Alabama (USAM), University of West Alabama Herbarium (UWAL), and Vanderbilt University (VDB), which is located at the Botanical Institute of Texas (BRIT) in Fort Worth.

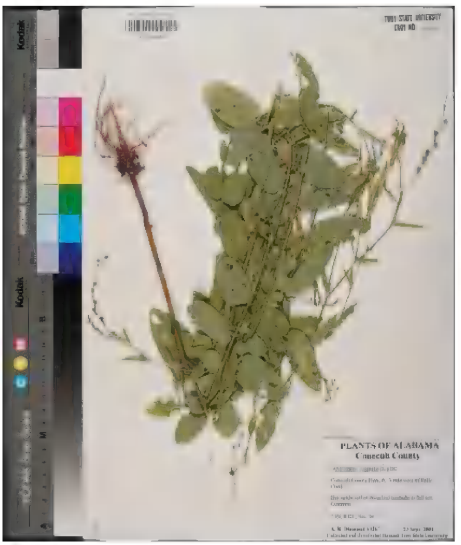

Figure 1. *Alysicarpus ovalifolius* from Conecuh County. Distribution in Alabama.

Figure 2. *Alysicarpus vaginalis* in Pike County. Distribution in Alabama.

RESULTS AND DISCUSSION

Both *Alysicarpus ovalifolius* and *A. vaginalis* occur in Alabama. When utilizing published treatments for the genus from other parts of the world, certain diagnostic features presented in the keys did not correlate well with the Alabama specimens. For example, Léonard (1954) described *A. ovalifolius* as having an open inflorescence with the flowers shorter than the internodes; while *A. vaginalis* have a dense inflorescence with the flowers longer than the internodes. In the Alabama plants, there were no distinguishable differences in the inflorescences. Huang and Ohashi (2010) described *A. ovalifolius* as having loments with ridges at the joints while *A. vaginalis* has loments with furrows at the joints. In the Alabama plants, loments of both taxa had ridges at the joints. Plants from Alabama are easily distinguished from one another as in the following couplet.

1. Annual, erect, 1.0–1.5 meters tall; lower and middle cauline leaves oblong or oblong-elliptical, 3.0–6.5 cm long and 2.0–3.0 cm wide, upper cauline reduced, 2.5–4.0 cm long and 0.25–1.5 cm wide; loments without septa between the joints ..... **Alysicarpus ovalifolius**

1. Perennial, procumbent to ascending, <0.5 meters tall; lower and middle cauline leaves orbicular to broadly oblong, 1.5–3.0 cm long and 1.0–2.0 cm wide, upper cauline lanceolate, 1.0–3.0 cm long and 0.25–1.0 cm wide; loments with septa between the joints ..... **Alysicarpus vaginalis**

Alysicarpus ovalifolius is known from two counties in Alabama (Fig. 1).

Specimens examined. Conecuh Co.: *Diamond 12677,* 25 Sep 2001 (ILLS, TROY, VDB). Mobile Co.: *Lelong 11799*, 29 Oct 1980 (USAM).

Alysicarpus vaginalis is known from three counties in Alabama (Fig. 2).

Specimens examined. Baldwin Co.: *Burkhalter 25679*, 30 Nov 2015 (UWFP), *Lelong 7391*, 10 Sep 1992 (USAM). Mobile Co.: *Burkhalter 19685* 31 Oct 2003 (UWFP), *Lelong 11716* 18 Oct 1980 (USAM). Pike Co.: *Diamond 24688*, 6 Nov 2013 (TROY, UWAL, VDB).

ACKNOWLEDGMENTS

The authors thank Dr. Michael Vincent for his verification of these two taxa.

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA
Part 19. EUDICOTS: POLYGALACEAE TO SIMMONDSIACEAE

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ABSTRACT

A floristic and natural history account is provided for 16 eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona — the heart of the Sonoran Desert. The 16 families include 33 genera with 52 taxa. At least 19 species are represented by fossil specimens from packrat middens, four of which are no longer present. This is the nineteenth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium: <http://cals.arizona.edu/herbarium>.

This contribution to our flora in southwestern Arizona includes sixteen eudicot families (Table 1). The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ). Family designations follow APG III and IV (Angiosperm Phylogeny Group 2009, 2016) and the Angiosperm Phylogeny Website (Stevens 2012). Non-native taxa established in the flora area are marked with an asterisk (*) and non-natives not established in the flora area are marked with double asterisks (**). Fossil specimens are indicated with a dagger symbol (†) and fossils of taxa no longer present in the flora area are marked with two dagger symbols (††).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2016). All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

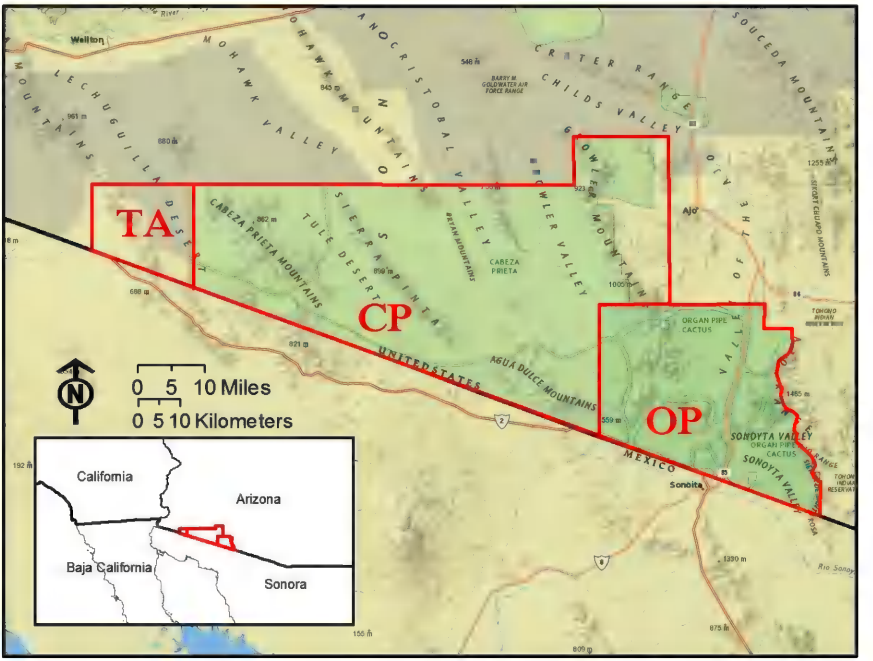

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

Table 1. Local distributions and growth forms of Polygalaceae, Polygonaceae, Portulacaceae, Primulaceae, Ranunculaceae, Resedaceae, Rosaceae, Resedaceae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Salicaceae, Santalaceae, Salicaceae, Simaroubaceae, Simmondsiaceae, Sapindaceae, and Simmondsiaceae. † = Modern species also represented by a fossil; †† = fossil taxa no longer present; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm-season ephemerals; WI = winter-spring/cool-season ephemerals; PR = perennials.

Taxon	Region			Growth Form			
				Ephemerals			Perennial
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Non-seasonal	
POLYGALACEAE							
Hebecarpa macradenia	OP						PR
POLYGONACEAE							
†*Chorizanthe brevicornu*	OP	CP	TA		WI		
†*Chorizanthe corrugata*	OP	CP	TA		WI		
†*Chorizanthe rigida*	OP	CP	TA		WI		
†*Eriogonum abertianum*	OP					NS	
Eriogonum deflexum	OP	CP				NS	

†*Eriogonum fasciculatum* var. *polifolium*	OP	CP	TA				PR
†*Eriogonum fasciculatum* var. *unknown*			TA				PR
Eriogonum inflatum	OP	CP	TA				PR
Eriogonum maculatum	OP				WI		
Eriogonum thomasii	OP	CP	TA		WI		
Eriogonum thurberi	OP	CP	TA		WI		
Eriogonum trichopes	OP	CP	TA			NS	
†*Eriogonum wrightii* var. *nodosum*	OP	CP	TA				PR
†*Eriogonum wrightii* var. unknown			TA				PR
Nemacaulis denudata		CP	TA		WI		
**Polygonum argyrocoleon*	OP	CP				NS	
Pterostegia drymarioides	OP				WI		
Rumex hymenosepalus	OP						PR
PORTULACACEAE							
Portulaca halimoides	OP	CP	TA	SU			
**Portulaca oleracea*	OP	CP		SU			
Portulaca suffrutescens	OP			SU			
Portulaca umbraticola	OP			SU			
PRIMULACEAE							
***Anagallis arvensis*	OP				WI		
Androsace occidentalis	OP				WI		
RANUNCULACEAE							
†*Anemone tuberosa*	OP		†TA				PR
Clematis drummondii	OP	CP					PR
Delphinium scaposum	OP	CP					PR
†*Myosurus cupulatus*	OP				WI		
Myosurus minimus	OP				WI		
††*Myosurus nitidus*	OP				WI		
Thalictrum fendleri	OP						PR
RESEDACEAE							
Oligomeris linifolia	OP	CP	TA		WI		
RHAMNACEAE							
††*Ceanothus vestitus*	OP						PR
Condalia globosa	OP	CP					PR
†*Condalia globosa* &/or *C. warnockii*	OP		TA				PR
Frangula betulifolia	OP						PR
Rhamnus crocea	OP						PR
†*Ziziphus obtusifolia*	OP	CP	TA				PR
RIVINACEAE							
Rivina humilis							PR
ROSACEAE							
†*Vauquelinia californica*	OP						PR
RUBIACEAE							
Galium aparine	OP				WI		
Galium microphyllum	OP						PR
†*Galium stellatum*	OP	CP	TA				PR

RUTACEAE							
Ptelea trifoliata	OP						PR
†*Thamnosma montana*		CP	TA				PR
SALICACEAE							
Populus fremontii	OP	CP					PR
Salix gooddingii	OP						PR
SANTALACEAE							
†*Phoradendron californicum*	OP	CP	TA				PR
††*Phoradendron juniperinum*	OP						PR
††*Phoradendron serotinum*	OP						PR
SAPINDACEAE							
Dodonaea viscosa	OP						PR
Sapindus drummondii	OP						PR
SIMAROUBACEAE							
Castela emoryi	OP	CP					PR
SIMMONDSIACEAE							
†*Simmondsia chinensis*	OP						PR

POLYGALACEAE – Milkwort Family

Herbs, vines, shrubs, and trees; worldwide; 24 genera, 965 species.

Hebecarpa

The single member of this family in the flora area is in the genus *Hebecarpa*, segregated from the polyphyletic *Polygala* sensu lato, and includes 40–70 species mostly in Mexico, with 9 species ranging into southwestern USA and a few extending to South America (Abbott 2011).

Hebecarpa macradenia (A. Gray) J.R. Abbott

[*Polygala macradenia* A. Gray]

Gland-leaf milkwort. Figure 2.

Small, densely branched perennials, to about 15 cm tall, from a somewhat woody base. Herbage densely pubescent and gland dotted. Leaves 3–8 mm long, subsessile or short petioled, lanceolate to elliptic-ovate. Flowers bilateral and somewhat pea-like (sometimes confused with legumes). Sepals 5, separate, including an enlarged wing-like lateral pair, purple and petal-like, each ca. 2.5 mm long. Corollas of 3 small, fused white and yellow petals. Stamens 8. Fruits oblong to narrowly ovoid capsules, ca. 5 mm long, pubescent and gland dotted. Flowering with sufficient soil moisture during warmer months.

Rocky soils, often granitic or other calcium-rich substrates, in hills and mountains, and often on arroyo and canyon slopes. Widely scattered across much of Organ Pipe except the arid southwestern part.

Southwestern USA except California and northern Mexico from Baja California and northern Sonora to Tamaulipas and Zacatecas.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. Canyon N of Alamo Canyon, 31 Mar 1948, *Darrow 3857*. Puerto Blanco Drive, 13 mi by road NW of Visitor Center, 10 May 1979, *Bowers 1714*. Gunsight Hills, granite, 24 Mar 2013, *Rutman*, photos.

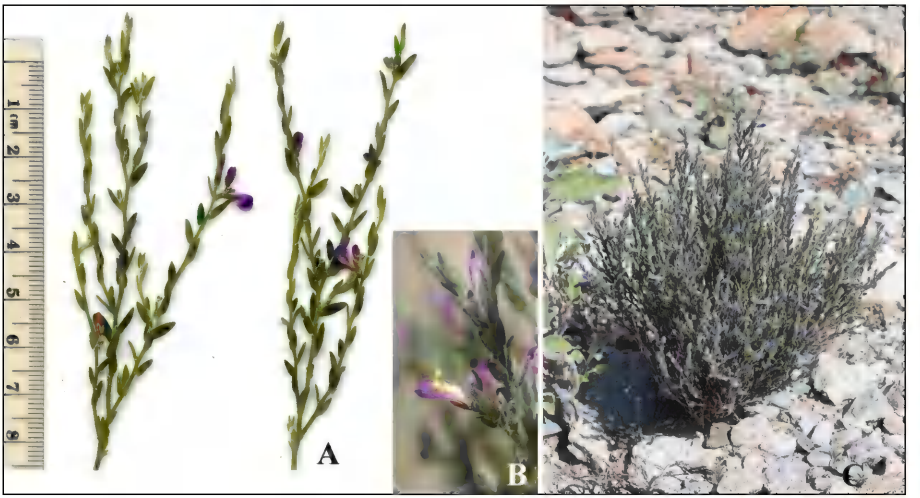

Figure 2. *Polygala macradenia*. (A) Gunsight Hills near E boundary of ORPI, 11 Mar 2015. Trail to Victoria Mine, Puerto Blanco Mts: (B) 1 Apr 2010; (C) 7 Feb 2014.

POLYGONACEAE – Buckwheat Family

Ephemerals/annuals or perennial herbs or small shrubs (those in the flora area; includes lianas and trees elsewhere). Stems often swollen at nodes with fused stipules enclosing (sheathing) the stem, or stipules reduced or absent. Leaves simple, alternate, or occasionally opposite or whorled, usually entire. Flowers mostly small and radial. Calyx in 1 or 2 series, often petal-like; petals none. Fruits 1-seeded achenes (those in the flora area).

Worldwide; 43 genera, 1110 species.

1. Stipules evident and sheathing the stems; subfamily **Polygonoideae**.

2. Leaves sessile or nearly so; flowers (calyx) 1.5–2.5 mm long…… **Polygonum**
2. Petioles well developed on the larger, lower leaves; flowers (calyx) more than 5 mm long. …… **Rumex**

1. Stipules absent; subfamily **Eriogonoideae**.

3. Ephemerals/annuals or perennials; involucral bracts united below to form a tube.

4. Small ephemerals; involucres bearing spine-tipped teeth and a single flower (flowers minute and often cryptic)…… **Chorizanthe**
4. Small ephemerals to woody perennials; involucres with blunt-tipped teeth or bracts and multiple flowered…… **Eriogonum**

3. Ephemerals; involucral bracts solitary or separate.

5. Plants with woolly hairs; leaves in a basal rosette, the blades several times longer than wide and pointed at the tip; Cabeza Prieta dunes..... **Nemacaulis**
5. Plants sparsely hairy, not woolly; leaves cauline (on the stem), the blades as wide or wider than long and usually notched; Organ Pipe..... **Pterostegia**

Chorizanthe – Spine flower

Small, spring ephemerals (annuals and some perennials elsewhere). Leaves entire, in basal rosettes and soon deciduous or withering, usually by early March, some leaves also alternate along stems; stipules none. Involucres with 3 or 6 teeth, these often spinescent and recurved; usually dimorphic. (The few involucres in the lower axils are solitary, larger, and less modified than those in the upper axils.) Flowers 1 per involucre, minute, white or yellow, the perianth barely protruding or hidden in firm, spinescent bracts; stamens often 9, 6, or 3. Flowering mostly February to March, the plants mostly mature before or during April. By the time the plants are in full flower with onset of fruiting, the weather is warm and the plants are leafless or nearly so.

Western North America and Chile; 50 species. The North American species are annuals with a taproot and leaves in a basal rosette, whereas the South American species are mostly perennials.

1. Stems stout and spiny, not breaking apart at maturity, the dry plants ("skeletons") tough and persistent; involucral tube as wide as long..... **Chorizanthe rigida**
1. Stems slender and not notably spiny, not persistent, the stems and inflorescences fragile and breaking apart at maturity; involucral tube longer than wide.

2. Leaves narrowly oblanceolate; involucre 6-toothed, with sharp recurved teeth 2–4 mm long, like tiny grappling hooks..... **Chorizanthe brevicornu**
2. Leaves broadly ovate to orbicular; involucre 3-parted, the teeth (segments) 2–7.5 mm long, not notably sharp or hooked..... **Chorizanthe corrugata**

Chorizanthe brevicornu Torrey subsp. **brevicornu**
Brittle spine-flower, short-horn spine-flower. Figure 3.

Plants (3) 5–25 cm tall, often wider than tall. Stems much-branched above (except when stunted); lower stems often reddish green; upper stems, inflorescence branches, and involucres mostly yellowish green. Internodes of fresh, young growth slightly swollen just below nodes. Dry mature stems brittle, breaking apart at nodes. Herbage with appressed white hairs. Basal rosette leaves (1) 1.8–8 cm × (1) 1.3–5 mm, narrowly oblanceolate without a distinct petiole, semi-succulent on young robust plants, very quickly withering; stem leaves reduced above. Involucres solitary at nodes, each subtended by recurved (hooked) bracts 2–3 mm long. Involucral tube straight or slightly curved, 3.5–4 mm long, cylindrical but 3-angled with 6 prominent ribs, each rib extending into a recurved, spinose tooth 1 mm long ("short-horned" as indicated by the specific name) like tiny grappling hooks. Perianth white, barely protruding from the involucre. Stamens 3. Achenes cylindrical, tightly enclosed by the involucre.

The dry, mature plants completely break apart and "disappear" during April or May. The propagules contain a stem segment with mostly 1–3 internodes and an involucre with its single seed. The rigid, sharp, and recurved teeth at both the base and tip of the involucre are like tiny grappling hooks attaching to skin, clothing, fur, or feathers. Apparently the seed germinates while enclosed in the involucre. There seems to be weak dimorphism in size and weight of disseminules: the lower stems, which are stouter and have longer internodes than the upper stems, produce stouter involucres in their axils than do those in the upper-stem axils.

Widespread and common across the flora area; washes and sandy flats to rocky slopes. Specimens more 10,000 years old are recorded for the Tinajas Altas Region.

Mojave, Sonoran, and Great Basin deserts in Arizona, Baja California, California, Nevada, southwestern New Mexico, northwestern Sonora, and Utah. Another subspecies occurs at elevations and latitudes above the desert from central California to Idaho and southeastern Oregon.

OP: Alamo Canyon, 14 Mar 1941, *Benson 10675*. Headquarters, *McDougall 10 Apr 1941*. Dripping Springs, 15 Apr 1952, *Parker 7912*. Aguajita, *Beale 8 Apr 1988* (ORPI).

CP: Canyon bottom, NE approach to Agua Dulce Pass, 13 Apr 1964, *Niles 344*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3930*. Pinta Sands, 11 Apr 1993, *Felger 93-395*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Steep canyon slope N of Tinajas Altas, 19 Mar 1998, Felger, observation. Tinajas Altas, bajada, 19 Mar 1998, *Felger*, observation. †Butler Mts, fruit-bearing segments (with hooks), 10,360 ybp.

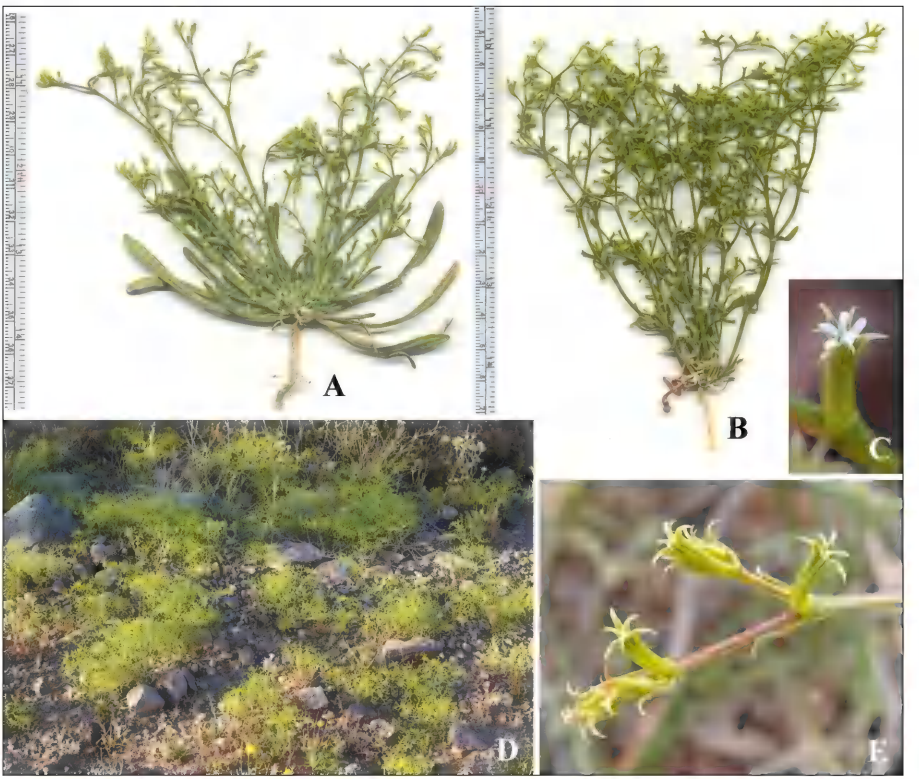

Figure 3. *Chorizanthe brevicornu* subsp. *brevicornu*. (A) El Huerfano, Sonora, 5 Mar 2014. (B) Below Gillespie Dam, Maricopa Co., 31 Mar 2013. (C & E) Flats E of Tinajas Altas, 2 Mar 2014, photos by Sue Carnahan. (D) Hat Mountain, Maricopa Co., 22 Mar 2014.

Chorizanthe corrugata (Torrey) Torrey & A. Gray
Wrinkled spine-flower. Figure 4.

Plants (1.5) 3–15 cm tall, compact, intricately branched above, as wide or wider than tall. Stems densely white hairy below, often glabrate above and with age. Leaves of basal rosette densely white woolly, conspicuously petioled, the blades (5) 8–30 mm long, broadly ovate to orbicular; stem leaves reduced above. Involucres densely crowded, yellow-green; hat-shaped, drying red-brown, firm and corrugated with transverse wrinkles. Involucral tube 2–3.7 mm long, cylindrical, with 3 lobes (teeth) 2–7.5 mm long, the tips recurved and moderately spinose; lobes of lower involucres markedly larger and broadly elliptic to ovate, the lobes of upper involucres smaller and narrower. Upon maturity the inflorescence quickly breaks apart into single-involucre pieces. Perianth white, barely protruding from the involucral tube. Stamens 6. Achenes 2.5 × 0.4 mm, cylindrical, smooth but not shiny, the tip 3-angled and minutely tuberculate, tightly enclosed in the hard involucral tube; seed disseminated with the involucre and apparently germinating while enclosed in it.

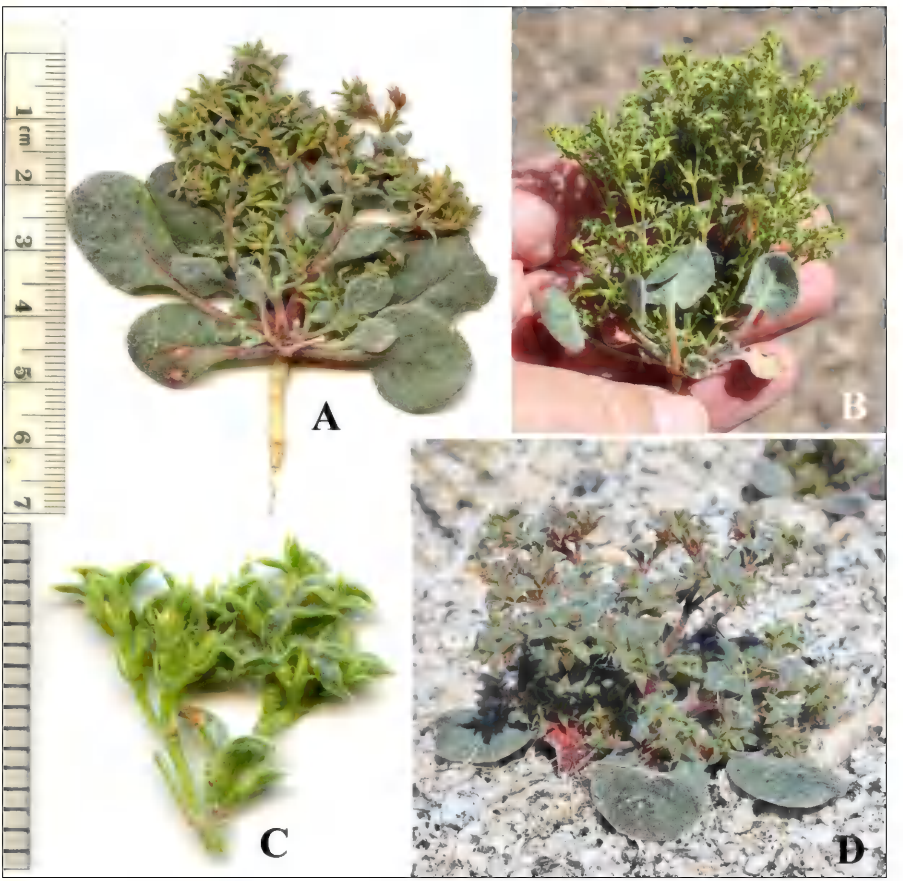

Figure 4. *Chorizanthe corrugata*. Sierra de Aguila, about 93 km W of Sonoyta on Mex Hwy 2, Sonora: (A & D) 7 Mar 2015; (C) 19 Mar 2015. (B) Vicinity of Los Vidrios, Mex Hwy 2, 17 Mar 2014.

Widely scattered in washes, sand flats, bajadas, and low rocky hills in the central portion Cabeza Prieta and a few records from Organ Pipe and one from Tinajas Altas. Generally aggregated in small, isolated populations. Many or perhaps most of the plants germinate in close proximity to their parent plant. A 2400-year-old specimen is recorded from the Puerto Blanco Mountains.

Western Arizona, southeastern California, southern Nevada, northeastern Baja California, and northwestern Sonora.

OP: 15 mi S of Bates Well, 1300 ft, sandy plains in open *Larrea-Franseria deltoidea*, 17 Mar 1945, *Gould 2982*. Flats 1.4 mi WSW of Bates Well, *Rutman 6 Apr 1998* (ORPI). †Puerto Blanco Mts, involucre, 2340 ybp.

CP: Tule Well, *Goodding 6 Mar 1940* (ASU). Davidson Canyon, 8 Apr 1979, *Lehto 23607* (ASU). Pinacate Lava Flow, 11 Apr 1978, *Lehto 22525* (ASU). Christmas Pass, 13 Apr 1992, *Harlan 267* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-394*.

TA: Tinajas Altas Pass, ca. 62.6 km (by air) SE of Yuma, 329 m, rocky granitic slope and derived grus, Mar 2014, *Van Devender*, photo (MABA/ARIZ).

Chorizanthe rigida (Torrey) Torrey & A. Gray
Devil's spine-flower. Figure 5.

Plants drying as a rigid, spiny skeleton resembling a miniature ocotillo and often persisting for a number of years. Plants (1) 2–10 cm tall with stout stems soon becoming rigid and obscured by crowded, rigid, straight spines. Some plants only 5 cm tall had taproots more than 25 cm deep. Larger leaves in a basal rosette as well as along the stem, the leaves soon withering; leaves petioled, the blades 6–32 mm long, ovate to orbicular, densely white woolly below, usually less so to sparsely white hairy above. Bracts spine-like, (4) 7–26 mm long. Involucres 3-angled and 3-toothed or segmented, the tube 2 mm long, about as wide as long and reticulated, the segments triangular to leaf-like, unequal, the longest one in the trio 4–20 mm long. Flowers minute, the perianth yellow-green and scarcely visible. Stamens 9. Achenes mostly 1.4–1.5 mm long, shiny red-brown, strongly 3-angled or -lobed and beaked. The size, length and width, weight, and even the shape of the involucral segments and size of the contained seed are highly variable, resulting in different dispersal characteristics (Martinez-Berdeja et al. 2014). The seed is tightly held in the involucre, even on dry dead plants more than one year old. Seedlings often germinate at the base of old dry plants that seem to serve as nurse plants.

Figure 5. *Chorizanthe rigida*. (A) Aguajita Wash near international boundary, 25 Feb 2015. (B & C) Near Black Tank, Crater Range, 29 Mar 2015; (B) skeleton of dead plant.

Common and widespread across the flora area; flats, rocky slopes, bajadas, and broad, gravelly washes. Its history in the Tinajas Altas Region extends to more than 8000 years.

Northwestern Sonora, Baja California, Arizona, southern Nevada, southwestern Utah, and southeastern California.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Dripping Springs, 15 Apr 1952, *Parker 7923*. Growler Mts, foothills, 16 Apr 1952, *Parker 7972*. Aguajita, *Beale 8 Apr 1988* (ORPI).

CP: 2 mi W of Organ Pipe on road to Papago Well, 31 Jan 1992, *Felger 92-1*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3936*. Pinta Sands, 11 Apr 1993, *Felger 93-396*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger*, (observation).

TA: Camino del Diablo SE of Raven Butte, 20 Feb 2005, *Felger 05-33*. Tinajas Altas, bajada and lower slopes, 19 Mar 1998, *Felger* (observation). †Butler Mts, 3-parted floral bracts, 740 to 8160 ybp (3 samples).

Eriogonum – Wild buckwheat

Annual or perennial herbs or small shrubs. Leaves basal or along stems, whorled or alternate, the margins entire or sometimes wavy or scalloped; without stipules. Flowers in involucres with 4 or 5 teeth or lobes (those in the flora area). Sepals (tepals) petal-like, in 2 series of 3 segments each. Stamens 9; styles 3. Achenes mostly 3-winged or 3-angled.

A diverse North American genus, 250 species mainly in western North America, and one of the more diverse genera in the flora area in terms of number of species (10) and growth forms. Stems and "seeds" (achenes) of various species were eaten by the Cahuillas and others (Bean & Saubel 1972).

1. Annuals or small shrubs; stems leafy (although drought deciduous).

2. Annuals, not woody.

3. Involucres pubescent but not glandular, the flowers glabrous; involucres 2–3 mm long, the teeth 4–6 mm long…… **Eriogonum abertianum**
3. Involucres and flowers glandular pubescent; involucres 1–1.5 (2) mm long, the teeth 0.4–0.8 mm long…… **Eriogonum maculatum**

2. Shrubs or subshrubs, usually somewhat woody at base.

4. Involucres (flowers) in dense, head-like clusters on top of a well-developed peduncle; involucres 2.5 mm long…… **Eriogonum fasciculatum**
4. Involucres solitary and sessile at nodes (flowering branch may appear racemose); involucres 1–1.7 mm long…… **Eriogonum wrightii**

1. Annuals or herbaceous perennials; stems not leafy or with much reduced leaves, the leaves largest and mostly at the base of the plant, often forming a basal rosette.

5. Annuals; bracts leafy, teeth of involucre longer than the tube…… **Eriogonum abertianum**
5. Annuals or herbaceous perennials; bracts not leafy, teeth of involucre shorter than or barely as long as the tube.

6. Leaves green, hairy but not woolly.

7. Perennials and flowering in first year; involucres 5-lobed; tepals (1.5) 2–2.7 (3.5) mm long. …… **Eriogonum inflatum**
7. Ephemerals; involucres 4-lobed; tepals 1.2–1.8 mm long…… **Eriogonum trichopes**

6. Leaves usually grayish green, and woolly/tomentose, at least below.

8. Flowering branches slender but not thread-like.

9. Involucres glabrous, 1.5–2.2 mm long…..... **Eriogonum deflexum**
9. Involucres and flowers glandular pubescent; involucres 1–1.5 (2) mm long. …..... **Eriogonum maculatum**

8. Flowering branches very slender—thread-like (filiform).

10. Flowering branches and involucres glabrous; involucres 0.8–2.3 mm long; outer tepals longer than wide, broadest and swollen (inflated) at base…… **Eriogonum thomasii**

10. Flowering branches and involucres glandular pubescent; involucres 2–3.2 mm long; outer tepals as wide as or wider than long, broadest above (towards the tip), narrowed at base to a claw…….... **Eriogonum thurberi**

Eriogonum abertianum Torrey
Abert's wild buckwheat. Figure 6.

Figure 6. *Eriogonum abertianum*. Alamo Wash: (A) 2 Aug 2014; (B) 26 Aug 2014; (C) 30 Mar 2008. (D) Estes Wash, 2 Aug 2014. (E) Coffeepot Mountain, Sikort Chuapo Mts, Maricopa Co., 27 Feb 2005.

Annuals 10–50 cm tall, pubescent, the herbage greenish to grayish or reddish. Leaves villous to tomentose; basal leaves petioled, the blades oblong to obovate, 1–4 cm long; upper stem leaves mostly sessile, reduced, linear, lanceolate, or narrowly obovate. Inflorescences open, 5–50 cm tall; branches hirsute; the bracts somewhat leaf-like. Peduncles, mostly straight, slender, villous to tomentose. Involucres broadly campanulate, 2–3 mm long and wide, villous-canescent; teeth 5, lobe-like, usually reflexed, 4–6 mm long. Flower in rounded, head-like clusters; flowers 3–4.5 mm long; perianth white to pale yellow, becoming pinkish or reddish, and glabrous; tepals dimorphic, those of the outer whorl orbiculate-cordate, those of the inner whorl lanceolate to spatulate. Achenes brown to dark brown, lens-shaped, 0.6–1 mm long. Flowering late winter and spring and with summer rains.

Eastern part of Organ Pipe including the Ajo, Diablo, and Puerto Blanco mountains. *Eriogonum abertianum* has been part of the Ajo Mountain flora for at least 20,500 years.

Eastward in southern and central Arizona to western Texas, Chihuahua, Coahuila, San Luis Potosí, and northern Sonora.

OP: Alamo Canyon, *Tinkham 18 Apr 1942*. Bull Pasture Trail, *Fox 1 Apr 1985*. Canyon Diablo, 21 Mar 1935, *Kearney 10833*. Dripping [Springs] Wells, 18 Mar 1945, *Gould 3015*. Montezuma's Head, W slopes, 16 Jan 1976, *Phillips 76-10*. Trail to Mt Ajo, near crestline above The Cones, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, involucres, 1150 & 9570 ybp. †Montezuma's Head, involucres, 20,490 ybp.

Eriogonum deflexum Torrey var. **deflexum**
[*E. deflexum* var. *turbinatum* (Small) Reveal]
Skeleton weed. Figure 7.

Ephemerals or annuals, often 5–50+ cm tall, with a well-developed taproot. Leaves in a basal rosette, 1.5–5 cm long, soon deciduous, the petioles prominent and usually longer than the blades, the blades orbicular, often cordate, especially the larger leaves; lower leaf-blade surfaces densely grayish-white woolly, the upper surfaces sparsely to densely woolly and often darker green. Flowering stems much-branched, the inflorescences more or less flat-topped, the stems leafless and glaucous, the larger ones relatively thick but not swollen. Involucres, pedicels, and outer tepal lobes glabrous. Involucres 5-lobed, 1.5–2.2 mm long, the pedicels 0.5–10 mm long. Perianth white or pink, the outer segments 1.8–2.3 mm long, orbicular to broadly elliptic, cordate, and blunt at tip. Often flowering late spring and sometimes into early summer, and sometimes persisting and flowering through summer and again in fall.

Washes, plains, and slopes, especially in open, disturbed habitats, and sometimes on rocky slopes to peak elevations; widespread across Organ Pipe and the eastern two-thirds of Cabeza Prieta. This one of the few annuals to survive and flower during the hot, dry late spring and early summer.

This species occurs from eastern California to Utah, Arizona, New Mexico, Baja California, and northern Sonora. Var. *deflexum* occupies a large portion of the range of the species; also 2 other varieties.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Growler Mts, foothills, 16 Apr 1952, *Parker 7979*. Quitobaquito, 13 Sep 1986, *Felger 86-267*.

CP: Childs Mtn, near summit, 18 Aug 1992, *Felger 92-642*. Cabeza Prieta Peak, S side of summit, 2550 ft, 24 Mar 1995, *Yeatts 3666* (CAB). O'Neill Hill, 9 Apr 1996, *Harlan 464*. Large wash SW of Scarface Mtn, *Rutman 22 Mar 2003*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger* (observation).

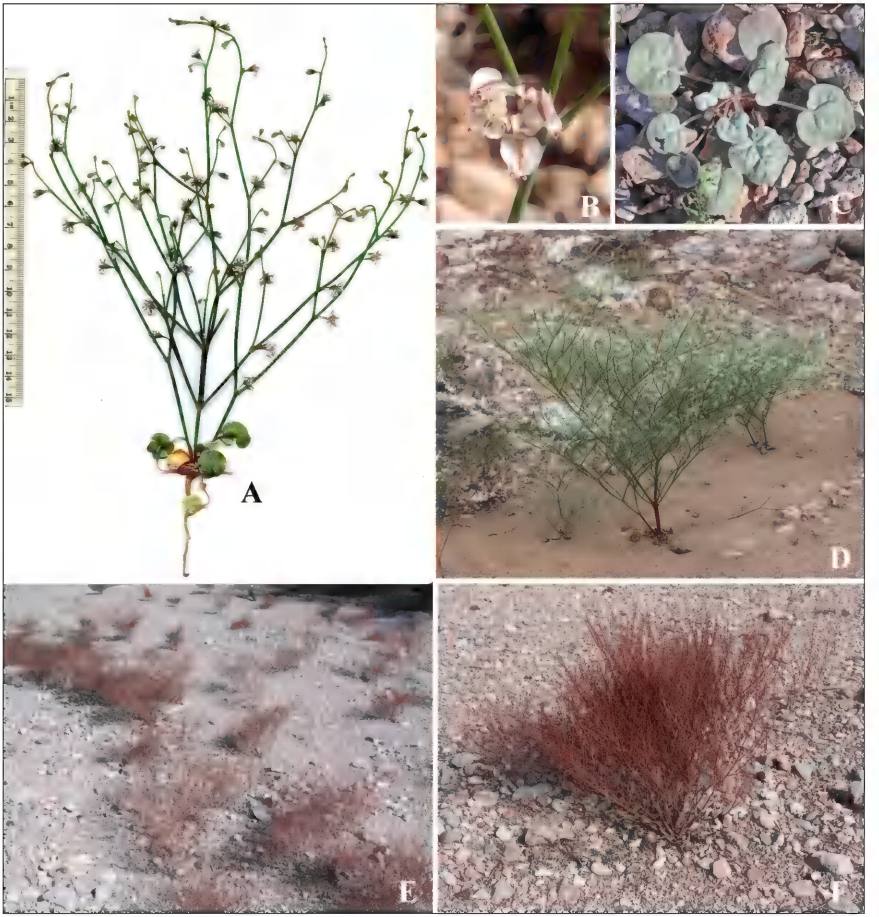

Figure 7. *Eriogonum deflexum* var. *deflexum*. (A) Acuña Valley, 15 Mar 2015. (B) Waterman Mountains, Ironwood Forest National Monument, 23 Feb 2013. Alamo Wash upstream from bridge: (C) 29 Jan 2014; (F) 28 Dec 2013. (D) Alamo Wash in Ajo Valley, 2 Aug 2014. (E) Kuakatch Wash near E boundary of Organ Pipe, 22 Jan 2005.

Eriogonum fasciculatum Bentham var. **polifolium** (Bentham) Torrey & A. Gray
Flat-top buckwheat. Figure 8.

Low spreading woody shrubs 0.5–0.8 (1) m tall, often compact and much-branched with leafy stems and shredding bark, the branches woody below. First-year stems, inflorescence branches, and peduncles conspicuously pubescent (canescent). Leaves fascicled, sessile or nearly so, 3–15 (18) mm long, linear to narrowly oblanceolate, white hairy on both surfaces—canescent above, densely woolly below; leaf margins and midrib on lower surface thick and prominent, the margins mostly revolute. Flowers crowded into compact, often clustered heads on long, leafless stems (scapes); involucres 5-toothed, 2.5 mm long, moderately to densely white hairy. Flowers white or pink, 3 (3.5)

mm long, the outer perianth segments densely white hairy mostly toward the base and along the broad midrib. Achenes 2–2.5 mm long. Flowering February to May and in fall.

Figure 8. *Eriogonum fasciculatum*. (A & B) Bull Pasture Trail, 8 Sep 2014. (C) 27 Feb 2014, Alamo Canyon. (D) 4 Apr 2015, Alamo Canyon

Widespread across the flora area, mostly higher elevations in canyons and rocky slopes of hills and mountains, especially north-facing, also upper bajadas and washes, and absent from lowland areas. This species has been part of the regional flora for at least 21,900 years.

This species occurs in western and southern Arizona to east-central California and southwestern Utah, Baja California, and northern Sonora. Variety *polifolium* is primarily in the desert and is the most common shrubby *Eriogonum* in southern Arizona. Four other varieties, mostly in California.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Walls Well, *Nichol 28 Apr 1939*. Alamo Canyon, 17 Apr 1952, *Parker 8009*. Sierra de Santa Rosa, 1600 ft, 11 Feb 1978, *Bowers 1033* (ORPI). †Variety unknown: Alamo Canyon, leaves, 1150 ybp. †Montezuma's Head, leaves, 13,500 & 21,840 ybp. †Puerto Blanco Mts, on ridge, leaves, 9070 ybp.

CP: N side of Tule Mts, 2 Feb 1992, *Felger 92-52*. Tuseral Tank, 14 Jun 1992, *Felger* (observation).

TA: Tinajas Altas, 27 Mar 1932, *Shreve 5942*. Tinajas Altas Mts, NE of upper tanks, 26 Oct 2004, *Felger 04-74*. †Butler Mts, leaves, 8160 to 11,060 ybp (3 samples). †Variety unknown: Tinajas Altas, leaves, 5080 to 18,700 ybp (7 samples).

Eriogonum inflatum Torrey & Frémont
Desert trumpet, bladder stem. Figure 9.

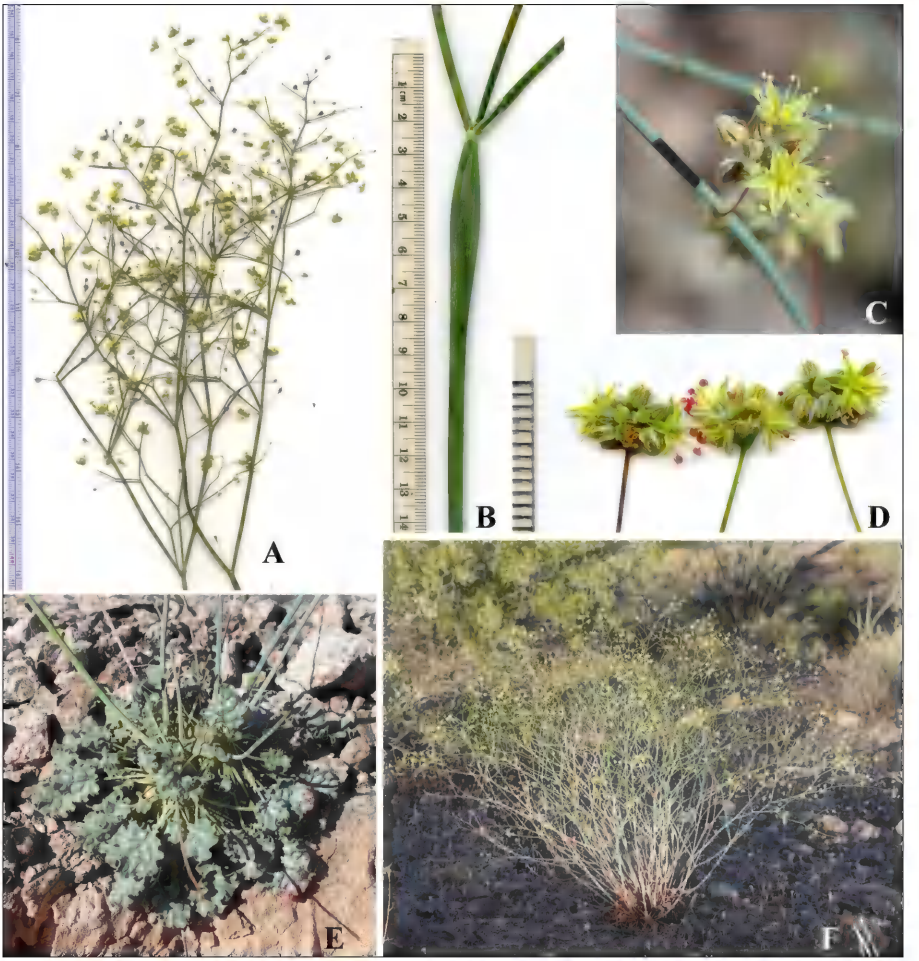

Figure 9. *Eriogonum inflatum*. (A) Darby Wells Road near Black Mountain, 17 Sep 2013. (B) Ajo Scenic Loop, Little Ajo Mts, 16 Mar 2015. (C) Lookout Mountain, Barry M. Goldwater Range, Maricopa Co., 12 Mar 2014. (D) Acuña Valley, 15 Mar 2015. (E) Roadcut on Hwy 85, N of Alamo Wash, 23 May 2010.

Herbaceous perennials with a hard, knotty base, also flowering in first season. Stems often many, leafless, glaucous to greenish; the first internode usually erect, often (7) 9–31 cm long, the upper part often inflated (swollen and hollow) with no apparent pattern. Second node (top of the first internode) commonly producing 2 or 3 (4–6) branches. Leaves basal or nearly so, green to reddish green, the dry leaves semi-persistent, the blades oblong to orbicular or kidney-shaped with wavy margins; petioles prominent. Involucres 5-toothed. Flowers yellow with red or green bases; tepals

mostly 2–2.7 mm long (as short as 1.5 at early anthesis to 3.5 mm as fruit develops), covered with whitish-translucent, fleshy, curved to curled hairs, the tepal margins glabrous and bright yellow. Flowering mostly in spring and again with the summer rains.

Common on rocky slopes, upper bajadas and sometimes along floodplains of larger washes, and generally absent from open desert flats; widespread across the flora area. *Eriogonum inflatum* has grown in the Tinajas Altas Region for more than 8200 years.

Deserts across much of Arizona, southern and east-central California to Colorado, Nevada, New Mexico, Utah, both Baja California states, and northwestern Sonora.

"The cause of the fistulose [inflated] stem and inflorescence branches in *Eriogonum inflatum* was imaginatively attributed by A.M. Stone and C.T. Mason (1979) to the larvae of gall insects. This fallacy continues to appear in the literature. Greenhouse studies have shown that stems of this and some other species of the genus inflate without the presence of any insects. Other researchers have shown that the inflation involves a build-up of CO_2 within the stems, which take over as the primary photosynthetic body as leaves wilt or eventually dry up and fall away from the plant (C.D. Osmond et al. 1987). Not all individuals of *E. inflatum* will have fistulose stems and branches, as this feature is partly a function of available moisture: the drier the conditions, the less pronounced the inflation. Stems produced in the summer tend to be inflated less frequently than those produced in the spring" (Reveal 2005: 386).

This *Eriogonum* is a food plant for the desert metalmark butterfly (*Apodemia mormo deserti*). The stems were harvested in spring before flowering and eaten fresh or cooked by the Cahuillas and others (Bean & Saubel 1972; Hodgson 2001).

OP: Bates Well, *Nichol 26 Apr 1939*. Ajo Valley, 20 Apr 1942, *Cooper 625*. Quitobaquito, 14 Sep 1988, *Felger 88-460*.

CP: Pinacate Lava, *Simmons 17 Oct 1962* (CAB). 4.7 mi E of Tule Well, 11 Apr 1993, *Felger 93-442*. Near Charlie Bell Pass, 9 Apr 1993, *Felger 93-339*. Agua Dulce Pass, Heart Tank, 13 & 14 Jun 1992, *Felger* (observations).

TA: Canyon below Raven Butte Tank, *Felger 10-226*. Cipriano Pass, N end of Tinajas Altas Mts, *Reeves 5441* (ASU). Above Tinajas Altas, 19 Mar 1998, *Felger* (observation). †Butler Mts, fruit with calyx, 8160 ybp.

Eriogonum maculatum A. Heller
Spotted wild-buckwheat

Cool-season annuals, perhaps persisting into summer, mostly 10–20 cm tall. Herbage and flowering stems usually tomentose. Basal rosettes leaves petioled, the blades lanceolate to obovate, 1–3 cm long, the stem leaves reduced. Flowering stems to 25 cm, tall; peduncles thread-like. Peduncles, involucres, and flowers glandular-pubescent. Involucres 1.5–3+ mm wide, with 5 teeth 0.4–0.8 mm long. Flowers 1–2.5 mm wide; perianth pale yellow, often becoming pink or reddish, the outer lobes (tepals) elliptic to rounded, the lower half inflated, the inner lobes lanceolate. Achenes 1–1.5 mm long, glabrous.

Documented from the flora area by a single specimen without specific locality.

California to eastern Washington, Idaho, Utah, southwestern New Mexico, Arizona, and Baja California. Mostly a species of the Great Basin, Mojave, and northern Sonoran Deserts.

OP: Organ Pipe National Monument, wash, 1798 ft, *Walden 18 Apr 1964* (ASU 11269, det. James L. Reveal 1968).

Eriogonum thomasii Torrey
Thomas's buckwheat. Figure 10.

Delicate winter-spring ephemerals, mostly (4) 8–15 cm tall (well-watered plants sometimes to 25+ cm). Leaves in a basal rosette, densely white woolly, the blades about as wide as long, ovate or circular to kidney-shaped, upper surfaces not as hairy and often greener than the lower surfaces, the petioles prominent. Flowering stems 1 or sometimes several to many, much-branched above, the branches very slender and glabrous. Involucres 5-lobed, glabrous, 0.8–1.2 mm long. Flowers 1.5–1.9 mm long, at first yellow, becoming pink below and white above, with age the outer tepals become swollen at the base, longer than wide, with short, stout, and minute glandular hairs below, otherwise glabrous.

Figure 10. *Eriogonum thomasii*. (A & B) Acuna Valley, 12 Mar 2015. (C & D) Granite-derived soil (grus) at base of Sierra del Águila, 93 km W of Sonoyta on Mex Hwy 2, 7 Mar 2015.

Widespread in the flora area; desert pavements and open gravelly-sandy areas of rocky slopes, bajadas, mesas, washes, canyons, and sand flats and dunes.

Primarily Mojave and Sonoran deserts; western Arizona, northwestern Sonora, Baja California, southeastern California, southern Nevada, and southwestern Utah.

OP: Puerto Blanco Mts, 2000 ft, *Nichol 25 Feb 1939*. Growler Mts, foothills, 16 Apr 1952, *Parker 7968*. Pozo Nuevo, 30 Mar 1978, *Bowers 1103*. Pitahaya Canyon, *Rutman 13 Mar 1998* (ORPI). Quitobaquito, 29 Mar 1988, *Felger 88-123*.

CP: Sandy soil, Pinacate Lava Fields, 30 Mar 1933, *Shreve 6213*. Papago Well, 22 Mar 1935, *Kearney 10871*. Little Tule Well, 9 Apr 1993, *Felger 93-333* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-393*.

TA: Tinajas Altas, 1900 ft, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-153*.

Eriogonum thurberi Torrey
Thurber's buckwheat. Figure 11.

Small winter-spring ephemerals about the same size and similar in general appearance to *E. thomasii*. Leaf blades ovate, broadly elliptic, or nearly orbicular, white woolly to moderately woolly and greenish, the margins nearly entire to crenate-lobed; petioles prominent. Peduncles and involucres densely glandular hairy, the hairs (stalks) whitish, the glands pinkish. Involucres 2–3.2 mm long, 5-lobed. Flowers 1.2–1.3 mm long, about as wide as long, the outer tepals white or pink, narrowed to a claw at the base.

Figure 11. *Eriogonum thurberi*. CD Trail, S of Engineer Canyon, Burro Mountains, Grant Co., New Mexico, 20 Apr 2010, photos by Russell Kleinman (gilaflora.com).

Generally on sandy-gravelly soils; near the Sonora border in Organ Pipe, Cabeza Prieta at least in the vicinity of Tule Well, and west of the Tinajas Altas Mountains and common in nearby northwestern Sonora.

Southern Arizona, southwestern New Mexico, southern California, Baja California, and northwestern Sonora.

OP: Senita Basin Road, 4.5 mi S of Senita Basin, 23 Mar 1969, *Lehto 15443-f* (ASU, det. James L. Reveal 1969).

CP: 1 km N of Tule Well, 11 Apr 1993, *Felger 93-438*.

TA: E edge of Davis Plain, west-branch of Camino del Diablo, *Felger 05-93*.

Eriogonum trichopes Torrey
Little desert-trumpet. Figure 12.

Winter-spring or spring-early summer ephemerals, occasionally persisting through summer and flowering again in fall. Plants usually broader than tall, with 1–several main stems, much-branched above into very slender branches, the plants extremely variable in size depending on soil moisture, (10) 30–50 (100) cm across. Larger plants may break off just below the surface after maturing and the upended plants may become tumbleweeds. Near the Mexican border "In early September 1992, I watched dust devils lift these tumbleweeds into the sky until they were no longer visible" (Felger 2000: 408). Stems yellow-green, glabrous and sometimes glaucous, the upper part of the first internode of larger branches sometimes inflated (especially among vigorously growing plants; see *E. inflatum*), the first internode usually erect or nearly so, (2) 5–10 cm long, the lateral branches whorled at most nodes, spreading nearly at right angles, the lower 1–several nodes often producing 3–17 branches, and even the upper nodes usually whorled. Leaves in a basal rosette, coarsely hairy, the blades broadly oblong to circular, (0.5) 1.5–5.5 cm long, the margins crenate to nearly entire; petioles (1) 4–13 cm long. Involucres 1 mm long, 4-lobed, glabrous, on elongated, slender spreading pedicels. Flowers yellow to greenish yellow, occasionally red-tinged. Tepals 1.2–1.8 mm long, the outer tepals covered with whitish-translucent, fleshy, curled hairs. Commonly flowering March–late April.

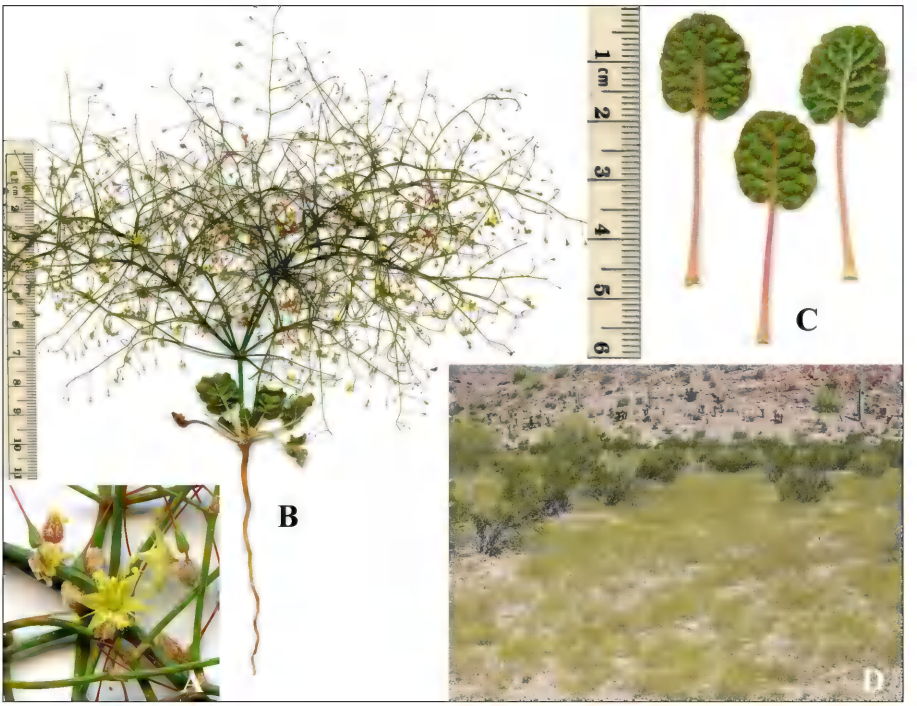

Figure 12. *Eriogonum trichopes*. (A & B) Ajo, 23 Mar 2015. (C) Midway Wash near Hwy 85, 8 Mar 2015. (D) Near Hat Mountain, Sauceda Mountains, Maricopa Co., 22 Mar 2014.

Widespread in Cabeza Prieta, especially the western part, Tinajas Altas, and Organ Pipe except the eastern margin; lower elevations including desert pavements, mesa tops, sandy plains, and alluvial flats, washes, and dunes.

Arizona to southeastern California, southern Nevada, southern New Mexico, southwestern Utah, Baja California, Chihuahua, and northwestern and central Sonora.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939*. Growler Mts, foothills, 17 Apr 1952, *Parker 7988*. Puerto Blanco Drive at old road to Dripping Springs, 12 Apr 1978, *Bowers 1253*.

CP: Flats E of O'Neill Pass, *Monson 24 May 1957*. Las Playas, 15 Apr 1964, *Niles 346*. Pinacate Lava Flow, 11 Apr 1992, *Harlan 191*. Pinta Sands, 15 Sep 1992, *Felger 92-776*.

TA: Camino del Diablo, SE of Raven Butte, *Felger 05-28*.

Eriogonum wrightii Torrey ex Bentham var. **nodosum** (Small) Reveal
[*E. wrightii* var. *pringlei* (J.M. Coulter & Fisher) Reveal]
Bastard-sage. Figure 13.

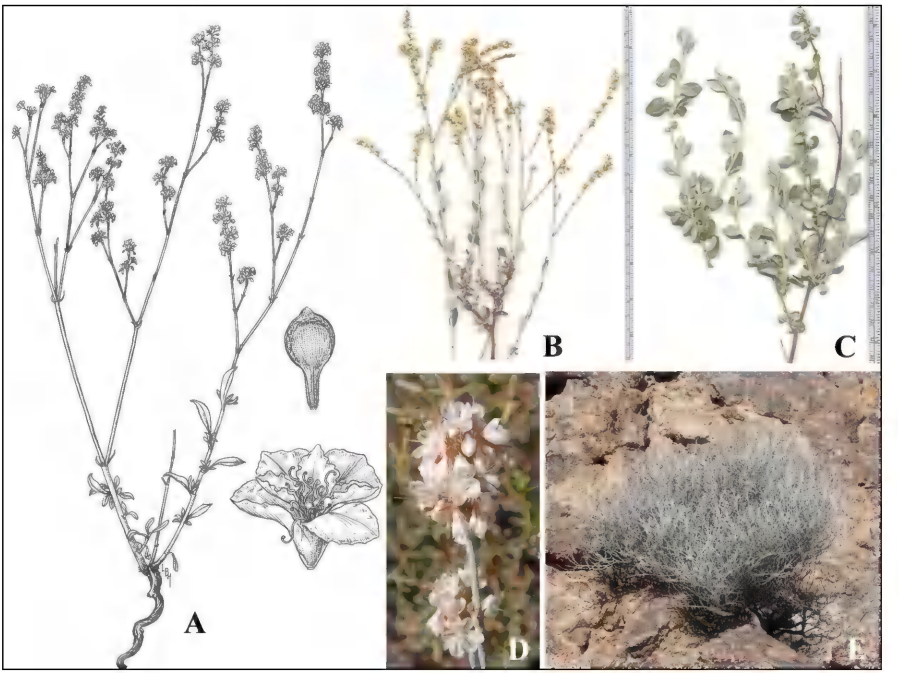

Figure 13. *Eriogonum wrightii*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon, 21 Sep 2008. (C) Estes Canyon, 31 Mar 2008. (D) Salero Ranch, 1 Oct 2013, photo by Sue Carnahan. (E) W of Hat Mountain ear Thanksgiving Day Tank, Sauceda Mts, 24 Mar 2016.

Messy-looking much-branched small shrubs 0.5–nearly 1 m tall, with slender whitish stems. Herbage generally densely white woolly. Leaves readily drought deciduous, the plants essentially leafless or with relatively few and reduced leaves in dry seasons; larger leaves on primary shoots 8–

25 mm long; leaf blades narrowly to broadly lanceolate or elliptic, the upper surfaces often more sparsely woolly than lower surfaces, gradually narrowed at the base into a sometimes prominent petiole, the smaller leaves sessile. Involucres solitary in axils (the floriferous stems appear racemose), more or less cylindrical, 1–2 mm long, 5-ribbed and 5-toothed, the perianth white or pink. Achenes short-beaked and ovoid, about as long as the involucre. Flowering response apparently non-seasonal with sufficient soil moisture, but perhaps not during summer.

Larger hills and mountains, especially north-facing slopes and canyons, throughout the flora area. This species has grown in the region for more than 37,000 years.

Var. *nodosum* occurs in the Sonoran Desert in southwestern and central Arizona, southeastern California, Baja California, and northwestern Sonora. It is the most arid-inhabiting of the approximately ten varieties in southwestern USA and northwestern Mexico.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. Bull Pasture Trail, 5 Nov 1977, *Bowers 931*. Sierra Santa Rosa, 11 Feb 1978, *Bowers 1033*. Arch Canyon, 2 Dec 1990, *Felger 90-562*. †Alamo Canyon, leaves, 8130 to 14,500 ybp (4 samples). †Variety unknown: Alamo Canyon, leaves, 8130 to 14,500 ybp (4 samples). †Puerto Blanco Mts, on ridge, twigs, leaves, 7560 to 14,1020 (8 samples).

CP: 3.2 mi E of Tule Well, 19 Feb 1979, *McLaughlin 1965*. Tule Tank, 23 Mar 1992, *Harlan 135*. Agua Dulce Tank, 13 Jun 1992, *Felger 92-568*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Tinajas Altas, 5 Dec 1935, *Goodding 1449*. Frontera Canyon, 18 Mar 1998, *Felger* (observation). †Variety unknown: Tinajas Altas, leaves, 5860 to 15,680 (14 samples), & >37,000 ybp.

Nemacaulis

This genus has a single species.

Nemacaulis denudata Nuttall var. **gracilis** Goodman & L.D. Benson

Woolly heads, cotton heads. Figure 14.

Spring ephemerals with delicate ascending and spreading stems, often as wide or wider than tall, with a well-developed taproot. Stems slender, mostly (7) 12–25 cm long; lower internodes relatively long, lower stems moderately pubescent with white hairs, upper stems thread-like and glabrate or glabrous. Leaves, nodes, bracts, and involucres densely white woolly; hairs on involucres often becoming brown with age. Leaves mostly in a basal rosette, (1.5) 2.6–5 (6.5+) cm × 2.6–5.5 (10) mm, narrowly oblanceolate; green or reddish beneath the dense white hairs, when wet the hairs instantly absorb water to become appressed and transparent, the midrib prominent; margins mostly undulate to sometimes entire; stem leaves few and reduced or absent. Flowering stems usually much-branched and diffuse. Involucral bracts separate, each subtending a single flower; bracts often yellow-green when young, otherwise reddish with conspicuous yellow-membranous margins, the larger, outer bracts 1.9–3 mm long. Flowers buried in wool of glomerules, yellow, 0.7–1.3 mm long, on slender pedicels; perianth segments 6. Seeds 0.75–0.9 mm long, smooth and shiny, dark brown to blackish, plump, shaped like a fat teardrop, the tip 3-angled.

Dunes and sand flats in the western part of Cabeza Prieta, especially in the vicinity of the Pinta Sands, and in the Tinajas Altas Region.

Southwestern Arizona, southern California (mostly inland deserts), both Baja California states, and northwestern Sonora. Another variety occurs in coastal California and Baja California. *Nemacaulis*, with a single species, can be distinguished from *Eriogonum* in having 3 rather than 9 stamens and the involucral bracts separate rather than united into a tube.

CP: Dunes, 6 mi W of O'Neill's Grave, 13 Mar 1983, *Eiber 27*. Pinta Sands, 10 Apr 1993, *Felger 93-392*.

TA: Butler Mts, *Van Devender 27 Mar 1983*.

Figure 14. *Nemacaulis denudata* var. *gracilis*. (A) Dunes near Mayan Palace, SE of Puerto Peñasco, Sonora, 20 Feb 2015. (B & C) Dunes 37 km SE of Sonoyta, Sonora, 20 Feb 2014.

Polygonum

Annual and perennial herbs and shrubs. Worldwide; 65 species.

***Polygonum argyrocoleon** Steudel ex Kunze

Silver-sheath knotweed. Figure 15.

Non-seasonal annuals with a stout taproot. Stems slender, erect to spreading. Stems and leaves glaucous, highly variable in size and number. Leaves alternate, sessile or nearly so, narrowly elliptic to narrowly lanceolate, mostly less than 1 cm long, sometimes 2–6 cm long, and soon deciduous; upper leaves usually reduced to bracts, the plants leafless or nearly so in drought or dry habitats; margins entire. Stipules fused, forming membranous sheaths around the stem above the usually swollen nodes. Flowers in small axillary clusters on terminal spike-like stems. Calyx petal-like, pink or white, 2–3 mm long. Achenes 3-angled, 2 mm long.

Locally common at Jose Juan Tank and perhaps other dirt charcos; germinating in wet soil. Common agricultural weed in nearby Sonora. The seeds are probably disseminated by birds. Also found in a 2005 roadside re-seeding in Organ Pipe.

A widespread weed, native to the Near and Middle East.

OP: Hwy 85, from roadside seeding, N of park headquarters, 9 Apr 2005, *Felger 05-161*.
CP: Jose Juan Tank, common in dried mud, not seen elsewhere, 12 Jun 1992, *Felger 92-562*

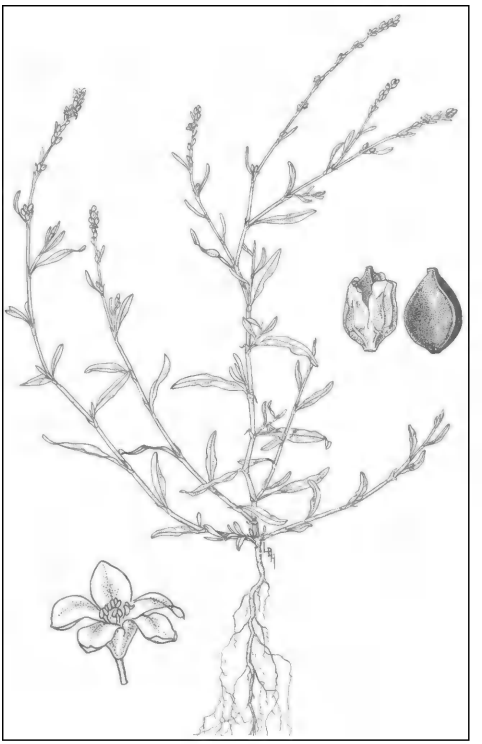

Figure 15. *Polygonum argyrocoleon*. By Lucretia Breazeale Hamilton

Pterostegia

This genus has a single species.

Pterostegia drymarioides Fischer & C.A. Meyer
Woodland thread-stem. Figure 16.

Delicate spring ephemerals with slender, fragile, and often trailing stems; sparsely pubescent. Leaves opposite; petioles to 1 cm long; leaf blades to 2 cm wide, broadly elliptic to fan-shaped, the margins entire or 2-lobed, the uppermost leaves reduced in size. Flowers 2 or 3 enclosed in a single bract; flowers reddish, the perianth 1 mm long, pale yellow or pink. Stamens 6. The fruiting involucral bract enlarging. Achenes 1–1.5 mm long.

Mountain canyons and major washes of Organ Pipe but apparently not in the Lower Colorado Valley areas of the southwestern part of the Monument. Mostly in moist habitats in canyons and on north-facing rocky slopes and cliffs, and locally in sandy soils, often in the shelter of shrubs.

Arizona, California, southern Nevada, southwestern Utah, Baja California, Baja California Sur, and expected in northern Sonora (documented within 1 km of Sonora in the Sierra Santa Rosa).

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10815*. Alamo Canyon, 14 Apr 1941, *McDougall 94*. Armenta Road 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-249*. Sierra Santa Rosa, 12 Mar 2003, *Felger 03-316*. Wash 1.2 mi NW of Kino Peak, 1510 ft, 20 Mar 2005, *Rutman 2005-0320-12* (ORPI).

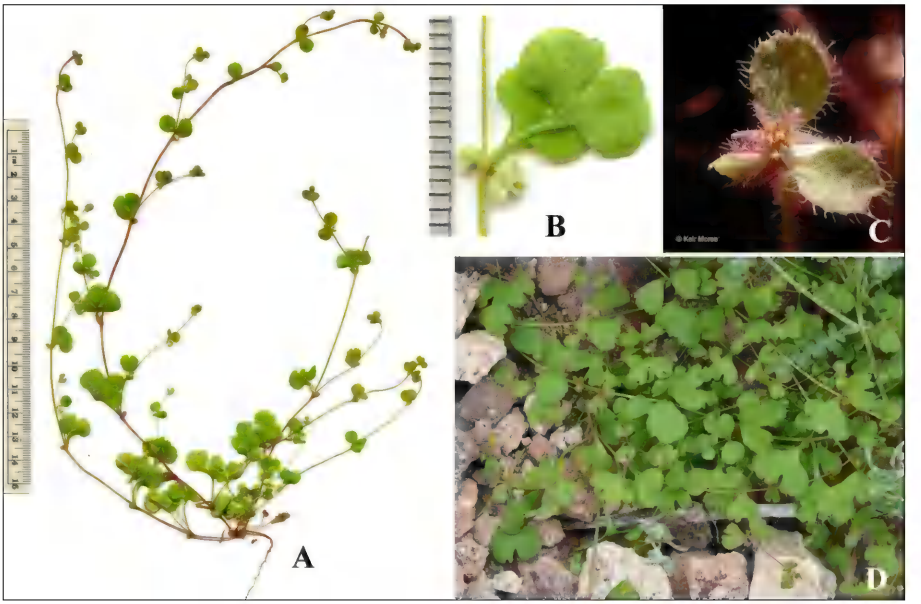

Figure 16. *Pterostegia drymarioides*. (A–B) Estes Canyon, 22 Mar 2015. (C) Joshua Tree National Park, San Bernardino Co., CA, 8 Apr 2005, photo by Keir Morse (SEINet). (D) Alamo Canyon, 18 Mar 2005.

Rumex – Dock; *cañaigre*

Annual and perennial herbs. Worldwide; 200 species.

Rumex hymenosepalus Torrey

Sand dock, wild rhubarb; *cañaigre*; wakondam. Figure 17.

Robust, herbaceous perennials from a cluster of thick, tuberous roots and short rhizomes. The plants die back during the summer and the new growth emerges during the cool season with flowering in late spring. Leaves alternate, mostly basal and petioled, the stem leaves reduced and often sessile above; larger leaves with blades to 25 m long, rather thick and sometimes slightly fleshy, lanceolate to oblong, the margins entire or wavy (crisped). Flowering stems often more than 30 cm tall. Inflorescences terminal and overtopping the leaves, narrowly paniculate and densely flowered. Perianth with an outer whorl of 3 smaller sepals and an inner whorl with 3 larger sepals (valves) 10–15 mm long, oblong to rounded-cordate, enlarging in the fruit (this species lacks a tubercle, a warty bump on the valves of various other *Rumex* species). Stamens 6; styles 3, the stigmas 3, red, broad, peltate, and conspicuously fringed.

Locally at the north side of Organ Pipe; scattered along the gravelly soil of Kuakatch Wash from near Walls Well to 5 km westward. Rutman's 1995 collection is probably the same area as MacDougal's 1907 observation.

Figure 17. *Rumex hymenosepalus*. (A) By Lucretia Breazeale Hamilton. (B–E) Kuakatch Wash near E boundary of Organ Pipe, 11 Mar 2015; 17E shows flowers with fringed, red stigmas.

Southwestern USA to Wyoming, and Baja California, northern Sonora, and Chihuahua.

The leaves and "stalks" of native and non-native species of dock were sometimes important food plants. They were cooked and eaten as greens, but because of citric, malic, and oxalic acids they were cooked in a change of water. The "seeds" (achenes) were also eaten (Hodgson 2001). Dock was an important food and medicinal plant among the Tohono O'odham (Castetter & Bell 1942).

The tuberous roots were an important sources of medicine in the region, and the plants were sometimes transplanted to home gardens (Rea 1997). The Tohono O'odham made yellow dyes for cotton fabrics from *R. crispus* and *R. hymenosepalus* roots (Castetter & Bell 1942). Most of the earlier ethnobotanical reports are not documented with specimens and species identifications might be questioned.

OP: Walls Well, Nov 1907, *MacDougal* (observation; Rose & Standley 1912). Sonoyta road 1 mi S of N entrance, 10 Apr 1941, *McDougall 82*. Kuakatch Wash near E boundary, *Rutman 15 Apr 1995* (ORPI).

PORTULACACEAE – Purslane Family

The APG systems trims the purslane family to a single genus. Genera formerly placed in this family include *Calandrinia*, *Cistanthe*, *Claytonia*, and *Phemeranthus* in Montiaceae and *Talinum* in Talinaceae.

Portulaca – Purslane

Summer ephemerals (those in the flora area; annual and perennial herbs elsewhere), succulents, especially the leaves. Stems leafy, the leaves alternate or subopposite; stipules none. Sepals 2, fused to lower part of ovary (the sepals interpreted as sepal-like bracts). Flowers brightly colored, opening in sunlight, the petals often lasting only a few hours and then deliquescent (dissolving or melting away; the petals interpreted as derived from sepals or staminodes). Fruit a capsule, circumscissile (opening more or less around the middle, the top coming off like a lid). Seeds many, variously sculptured or ornamented, usually with a white strophiole (a seed outgrowth that regulates water movement in and out of the seed). Worldwide; at least 100 species.

1. Leaf axils and flower clusters densely white-hairy; leaves terete (may appear flat when dry).

2. Roots not tuberous; flowers 3–7 mm wide, the sepals red-pink and somewhat persistent, the petals yellow but often hidden or seldom seen…….... **Portulaca halimoides**
2. Roots tuberous; flowers to 25 mm wide, the petals coppery orange……. **Portulaca suffrutescens**

1. Plants glabrous or essentially so (sometimes with a few inconspicuous hairs); leaves thick but flattened

3. Capsule rim not collar-winged, the capsule opening about at the middle, the lid conical. …….. **Portulaca oleracea**
3. Capsule rim surrounded by a collar-like wing 1–2 mm wide, the capsule opening above the middle, the lid shallow and saucer-like…….. **Portulaca umbraticola**

Portulaca halimoides Linnaeus
[*P. parvula* A. Gray]
Silk-cotton purslane. Figure 18.

Plants often diminutive with slender stems 2–12 cm long, but sometimes fairly robust when well-watered. Stems scarcely succulent when mature, often bright pinkish red. Leaves green, nearly terete but slightly flattened when fresh, 7–23 mm long. Long, silky white hairs in leaf axils and surrounding flowers. Sepals red-pink and relatively persistent; petals, anthers, and stigma golden yellow but only evident while the flowers are open—generally from a few hours after sunrise until late morning or midday. Petals 4 mm long, about as long to slightly longer than the sepals. Capsules 1.3–1.6 mm wide, the lid separating slightly below the middle. Seeds 0.5–0.6 mm maximum width, reddish brown to iridescent (metallic) blackish blue, cochleate (snail-shaped), and studded with star-shaped tubercles, their radii (arms) short; strophiole white.

Often seasonally common or even abundant on lower bajadas, washes and floodplains such as the southwestern part of Organ Pipe, Daniels Wash, and Coyote Wash.

Arid and tropical America from southwestern North America and Florida to Brazil and Peru.

Figure 18. *Portulaca halimoides*. (A) Sedona, Yavapai Co., 29 Aug 2005, photo by Max Licher (SEINet). (B) N of Summerford Mountain in black grama grassland, Jornada Long Term Ecological Reserve, Dona Aña Co., NM, 15 Aug 2008, photo by Patrick Alexander. (C) Mojave National Preserve, San Bernardino Co., CA, 23 Sep 2011. (D) Mojave National Preserve, San Bernardino Co., CA, 24 Sep 2011; photos by Keir Morse.

OP: 0.5 km W of Lukeville, 10 Nov 1987, *Felger 87-281*. Aguajita Wash, 14 Sep 1988, *Felger 88-433*. Hocker Well, 3 Dec 1990, *Felger 90-576*.

CP: Pinta Sands, *Edwards 8 Oct 1977* (ASU). Daniels Arroyo, 26 Sep 1992, *Harlan 305*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-61*.

***Portulaca oleracea** Linnaeus

Purslane; *verdolaga*; ku'ukpalk. Figure 19.

Plants erect to spreading or prostrate with age and size; glabrous except a few inconspicuous axillary hairs. Stems usually much-branched, relatively thick and succulent except in stunted plants. Herbage green or reddish late in the season. Leaves mostly 1–1.5 cm long, alternate or subopposite, flattened, spatulate to obovate, truncate to moderately notched. Sepals green, winged near the tip, the wings persistent on the capsule lid. (The wings narrower during drought and late in the season.) Petals, stamens, and stigma yellow, the petals 5–5.5 mm long, broadly oblong to obovate, deeply notched at apex. Capsules separating at about the middle, the capsule lid conical with at least 1 seed usually remaining with the lid, the others falling quickly. Seeds 0.6–0.8 mm wide, numerous, dull reddish brown to blackish, granulate, with low star-shaped (stellate) tubercles, their rays touching or interlocking, and a thin white strophiole.

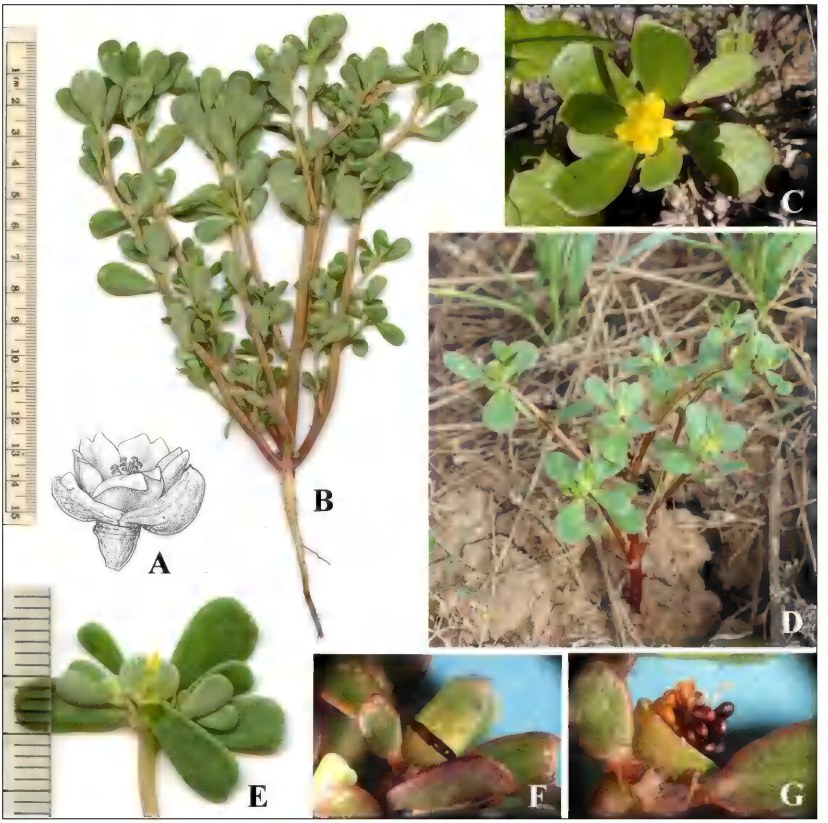

Figure 19. *Portulaca oleracea*. (A) By Lucreatia Breazeale Hamilton. (B & D) Hwy 86 roadside, mile 62, 1 Aug 2014. (C) Salero Ranch, Santa Cruz Co., 27 Jul 2013, photo by Sue Carnahan. (E) Dunes 37 km SW of Sonoyta on Hwy 8, 14 Sep 2014. (F & G) El Cerrito, Contra Costa Co., CA, 10 Aug 2011, photos by Zoya Akulova (CalPhotos).

Seasonally common in washes and floodplains in scattered localities in Organ Pipe and playas in Cabeza Prieta.

Worldwide in tropical to warm-temperate climates, mostly weedy; often difficult to determine which populations might be native. *Portulaca oleracea* may have been in the New World in pre-contact times.

This popular potherb has "the highest content of omega-3 fatty acids and antioxidants of any green leafy vegetable examined to date, suggesting that common purslane should be considered for its nutritional value and not for its weediness" (Matthews 2003: 499). "You would gather it and wash it and then boil it until it was tender, the same way as the other grass plants. You could refry it with butter and onions and it would be very good" (Betty Melvin in Zepeda 1985: 62).

OP: Aguajita, 14 Sep 1988, *Felger 88-432*. 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-318*. Bull Pasture, *Wirt 29 Jul 1990*. Dripping Springs, *Wirt 25 Jul 1990*. 0.5 mi W of Gachado Junction, *Wirt 25 Jul 1990*.

CP: Las Playas, 28 Nov 2001, *Felger 01-554*.

Portulaca suffrutescens Engelmann
Figure 20.

Ephemerals (those in the flora area, perennials elsewhere) with small, tuberous roots. Mature stems scarcely succulent. Leaves linear-terete, often to 10 mm long. Conspicuous white hairs in leaf axils and among the flowers and fruits. Flowers relatively large, to 2.5 cm wide, the petals coppery orange. Capsules 2.5 mm or more wide, subglobose. Seeds 0.5–0.65 mm wide, usually with raised, stellate tubercles.

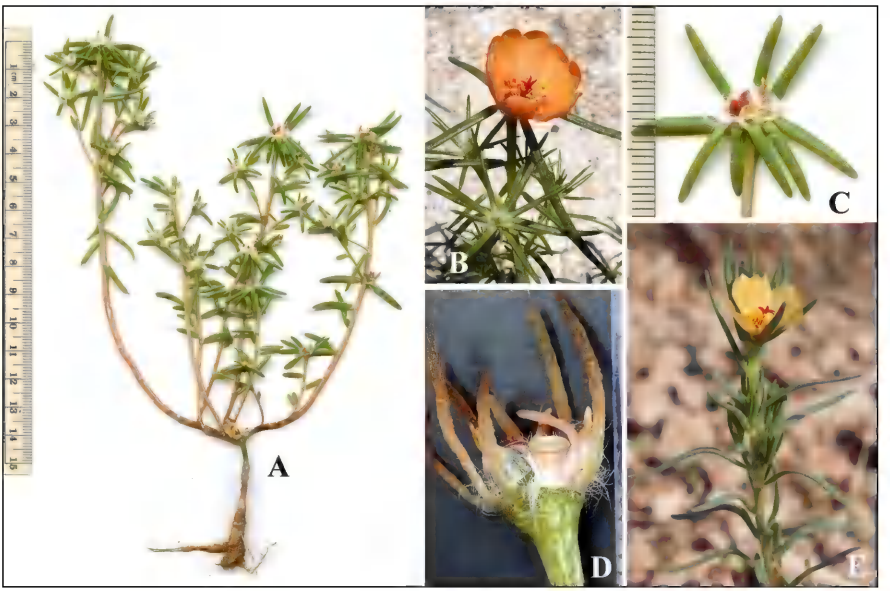

Figure 20. *Portulaca suffrutescens*. (A & C) Thin soil over bedrock, Bull Pasture Trail, 19 Sep 2014. (B) Salero Ranch, Santa Cruz Co., 27 Jul 2013, photo by Sue Carnahan. (D) Capsule with lid already gone (center) and a capsule still with its lid (left), Bill Evans Lake, Burro Mountains, NM, Grant Co., 31 Oct 2009, photo by Russell Kleinman (gilaflora.com). (E) Below the arch, Arch Canyon, 2 Aug 2013.

Common in the Ajo Mountains on shallow soil over rock, sometimes in mats of *Selaginella arizonica*. This species is an annual in the Sonoran Desert even though the roots are tuberous; elsewhere it is often perennial.

Eastward in southern and central Arizona to western Texas and southward to central Mexico.

OP: Bull Pasture, 9 Aug 1979, *Bowers 1799* (ORPI). Bull Pasture Basin, 24 Sep 2006, *Rutman 2006-0924-5*. Arch Canyon, trail to the arch, 2 Aug 2013, *Rutman 20130802-1*.

Portulaca umbraticola Kunth
[*P. coronata* Small. *P. lanceolata* Engelmann. *P. umbraticola* subsp. *lanceolata* (Engelmann) J.F. Matthews & Ketron]
Winged purslane. Figure 21.

Plants similar to those of *P. oleracea*. Glabrous except a few hairs at nodes and among the flowers and fruits. Leaves flat, obovate or lanceolate, 10–20+ mm long, the tip truncate to rounded. Flowers 10 mm wide, the petals yellow. Capsules 3–5 mm wide with a conspicuous collar-like wing 1–2 mm wide surrounding the capsule rim, capsules opening above the middle to shed a flattish, shallow saucer-like lid. Seeds 0.5–1 mm wide, dull gray, the tubercles stellate with prominent peg-like projections.

Ajo Mountains, sometimes in rock crevices.

Widespread in the Americas. Matthews & Ketron (1991) recognized 3 weakly differentiated subspecies; populations in southwestern Arizona would be subsp. *lanceolata*, which occurs in southern USA and Mexico.

OP: Bull Pasture: 11 Sep 1988, *Wilson 193*; *Wirt 23 Aug 1990* (ORPI).

Figure 21. *Portulaca umbracticola*. Thin soil over bedrock, below the arch, Arch Canyon: (A) 12 Sep 2014; (B & D) 16 Sep 2006. (C) Salero Ranch, 7 Aug 2013, photo by Sue Carnahan.

PRIMULACEAE – Primrose Family

Worldwide; annuals, herbaceous perennials, shrubs, and trees; 58 genera, 2590 species.

***Anagallis**

Annual and perennial herbs. Eurasia; 20 species.

****Anagallis arvensis** Linnaeus subsp. **arvensis**

[*Lysimachia arvensis* (Linnaeus) U. Manns & Anderberg]

Scarlet pimpernel. Figure 22.

Delicate winter-spring annuals. Stems, slender and leafy, often trailing. Leaves opposite or whorled, often 5–15+ mm long, glabrous, sessile, ovate and entire. Flowers radial, 5-merous, on long pedicels; solitary in leaf axils. Calyx about as long as the corolla. Corollas 5-lobed, 5 mm long, pale orange, with stalked glands. Fruits of circumscissile capsules.

Figure 22. *Anagallis arvensis* subsp. *arvensis*. (A) Pinnacles National Monument, San Benito Co., CA, 23 Apr 2004, photo by Keir Morse. (B) Ruby, Santa Cruz Co., 16 Apr 2014, photo by Sue Carnahan. (C) Deer Creek Center, Selma, Josephine Co., OR, 31 May 2007, photo by Keir Morse.

Occasional garden weed at the Organ Pipe headquarters and doubtfully establishing in natural habitats in the region. The plants are toxic to people and livestock.

Worldwide garden weed, native to Europe.

OP: Flowerbed at Resource Center, *Beale 2 Apr 1988* (ORPI). Residence area, 30 Mar 1988, *Felger 88-138*.

Androsace

Annual and perennial herbs. Northern Hemisphere, mostly temperate and arctic; 100 species.

Androsace occidentalis Pursh

[*A. occidentalis* var. *arizonicus* (A. Gray) H. St. John]

Western rock-jasmine. Figure 23.

Small winter-spring ephemerals; plants often reddish, 3–10+ cm tall. Leaves in a small basal rosette; 5–15 mm long, sessile, lanceolate-elliptic, entire to finely toothed; stipules none. Stems

upright, firm, supporting an inflorescences of small, scapose umbels subtended by involucral bracts 2–5 mm long. Flowers radial, 5-merous. Calyx 2.8–5 mm long, hairy, deeply 5-lobed, the calyx tube scarious, the lobes about half as long to equaling the tube. Corollas shorter than the calyx, 5-lobed, white and sometimes with a pink tinge. Fruits of capsules, rounded and 5-valved, 3–5 mm long, with many seeds.

Diablo Mountain canyons and more widespread in Ajo Mountain canyons and on slopes to the crestline where it can be seasonally abundant.

Elsewhere in Arizona mostly above the desert. Canada to northern Mexico.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10851*. Alamo Canyon, 14 Mar 1941, *Benson 10684*. Arch Canyon, 11 Mar 1983, *Daniel 2612* (ASU). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-269*.

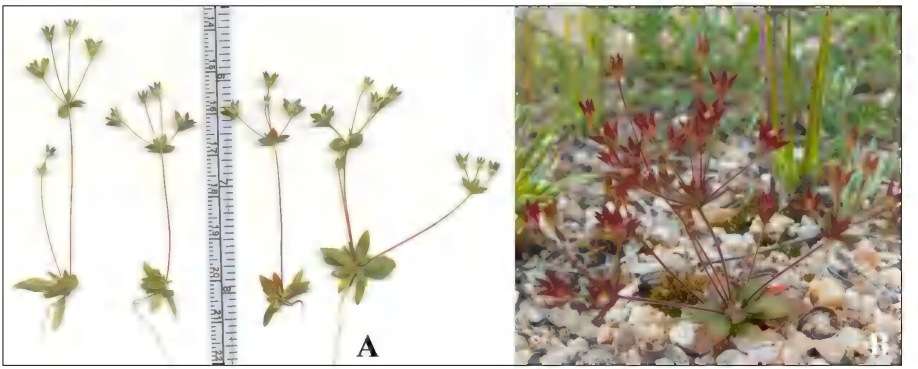

Figure 23. *Androsace occidentalis*. (A) Estes Canyon, 2 Mar 2008. (B) Dove Valley Trail, McDowell Mountain Preserve, Maricopa Co., 12 Mar 2015, photo by Steve Jones (SEINet).

RANUNCULACEAE – Ranunculus Family

Ephemerals, annuals, perennial herbs, and vines (those in the flora area; elsewhere also some shrubs). Leaves alternate, opposite, or in basal rosettes. Flowers highly variable, radial or bilateral, the floral parts separate. Stamens many. Pistils 1–many.

Worldwide, mostly temperate; 62 genera, 2525 species.

1. Perennial vines..... **Clematis**
1. Annual or perennial herbs, not vining.

2. Diminutive ephemerals; leaves linear and entire..... **Myosurus**
2. Root perennials; leaf blades about as wide as long, lobed to deeply dissected or compound.

3. Leaves 2-4 times pinnately compound..... **Thalictrum**
3. Leaves lobed to deeply dissected.

4. Stems usually less than 20 cm tall; flowers whitish to pink, radial, one to several on each stalk; sepals 5, petals none..... **Anemone**
4. Stems usually more than 20 cm tall; flowers dark blue, bilateral, several to many on each stalk; sepals 5, petals 4..... **Delphinium**

Anemone

Herbaceous perennials, worldwide; 150 species.

Anemone tuberosa Rydberg
Desert wind-flower. Figure 24.

Herbaceous perennials from thick, tuberous roots, growing during the cooler months of the year. Stems usually less than 20 cm tall. Leaves in a basal rosette, glabrous or essential so, petioles 5–7 cm long, the blades 3 cm long, divided into 3 segments, each one irregularly divided into deeply cleft, toothed segments. Flowers radial, one to several on each stalk, the receptacle elongating in fruit, the sepals 8–10 in number, 1–1.5 cm long, linear-oblong, whitish to pale rose-pink and quickly deciduous; flowering March and April. Stamens 50 or more. Fruits of achenes 3 mm long, aggregated in a cone-like short, thick column.

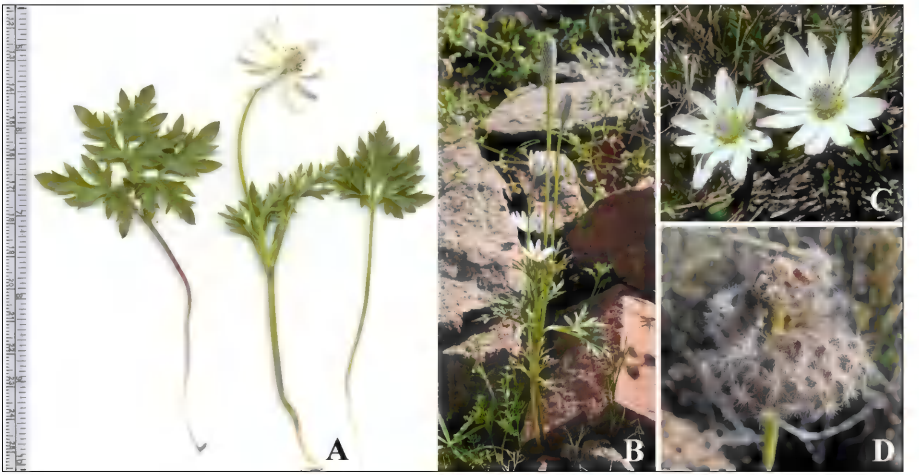

Figure 24. *Anemone tuberosa*. Estes Canyon: (A) 31 Mar 2008; (B) 27 Feb 2005. (C) Ghost Town Trail, Salero Ranch, Santa Cruz Co., 11 Feb 2014, photo by Sue Carnahan. (D) Canyon slopes along Upper Verde River N of Clarkdale, Yavapai Co., 13 Apr 2013, photo by Frankie Coburn (SEINet).

Canyons and often on north-facing slopes in the Ajo Mountains, especially at higher elevations. It has grown in the Ajo Mountains for at least 20,500 years and more than 9900 years ago it was in the Tinajas Altas Mountains.

Eastward and northward in southern and central Arizona to Texas, Utah, eastern California, Baja California, and northern Sonora to Nuevo León.

CP: Growler Mts, vicinity of Growler Peak, just N of Charlie Bell Pass, 302775 E, 3587989 N, *Peter Holm 4 Apr 2014*.

OP: Alamo Canyon, *McDougall 16 Apr 1941*. Grass Canyon, 1 mi from end of road, 26 Feb 1978, *Bowers 1086* (ORPI). Trail to crestline, above The Cones , 4025 ft, 10 Apr 2005, *Felger 05-266*. †Alamo Canyon, seeds, 14,500 ybp. †Montezuma's Head, seed, 20,490 ybp.

TA: †Tinajas Altas, seeds, 9900 ybp.

Clematis

Perennial vines, worldwide; 300 species.

Clematis drummondii Torrey & A. Gray

Texas virgin-bower; *barbas de chivato*. Figure 25.

Robust, perennial vines, often with woody bases, winter-dormant, climbing to the tops of shrubs and trees, with tendril-like petioles and leaf rachises. Leaves opposite, long-petioled, odd-pinnate, mostly with 5 leaflets; leaflets 1.5–5 cm long, deltate to ovate, 3-cleft or parted, the margins variously toothed. Inflorescences with several or more flowers in simple or compound cymes. Flowers radial, unisexual, mostly with male and female flowers on separate plants (polygamodioecious). Sepals 4, white to pale yellowish, about 1 cm long; petals none. Male flowers with 40 or more stamens; female flowers with more than 30 pistils. Fruits of small achenes each with a persistent feathery white beak (the persistent elongated style) 4–9 cm long. Flowering mostly summer and early fall, the fruits in conspicuous rounded clusters, feathery and white.

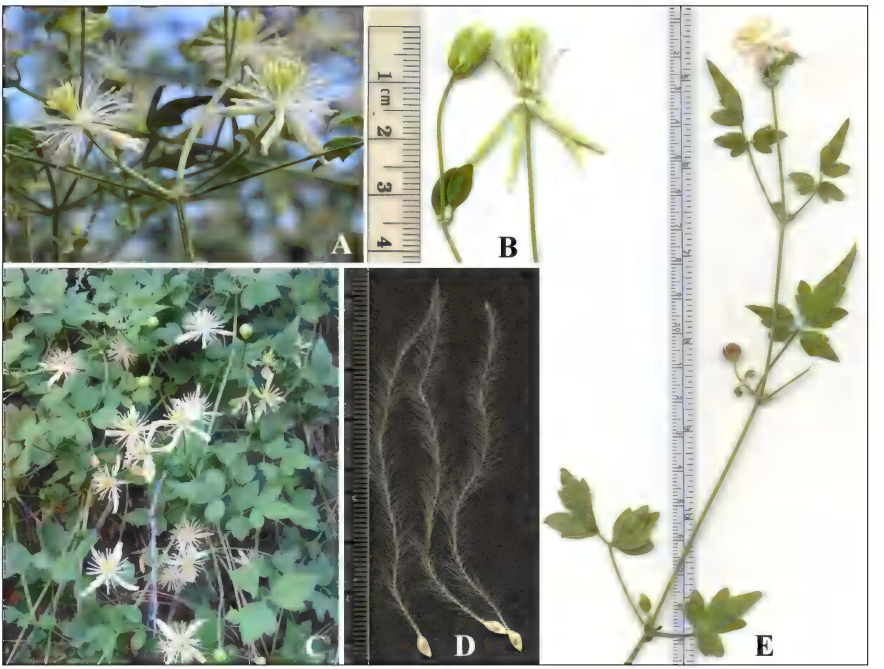

Figure 25. *Clematis drummondii*. (A) Staminate flowers, Kuakatch Wash near E boundary of Organ Pipe, 10 Sep 2013. (B) Pistillate flower, E branch of Daniels Arroyo, 5 Sep 2014. (C) Cuerda de Leña, 17 Sep 2013. (D) E Crater Range, Maricopa Co., 5 Nov 2014. (E) Staminate flower, Bates Well Road, S of Black Mountain, 17 Aug 2008.

Often festooning mesquites and blue palo verde trees along major washes, canyons, and at the edges of some charcos. Widely scattered in Organ Pipe except the southwestern portion and in the eastern part of Cabeza Prieta and northwest to Monreal Well.

Arizona to west Texas, Baja California Sur, and Sonora to Tamaulipas, Nuevo León and Puebla.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Bates Well, 25 Nov 1939, *Harbison 25672*. Cuerda de Leña Wash at N boundary, 13 Sep 1978, *Bowers 1534*. 1 mi E of Lukeville, 11 Nov 1987, *Felger 87-326*. Canyon NW of Kino Peak, 2000 ft, *Tibbitts 20 Mar 2005* (ORPI).

CP: Bluebird Mine (Simmons 1966). Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-670* (ASU). Jose Juan Represo, 14 Sep 1992, *Felger 92-722*. Road to Lower Well, 25 Feb 1993, *Felger 93-71*. Monreal Well, 14 Jun 1992, *Felger* (observation).

Delphinium – Larkspur

Perennial herbs, worldwide; 300 species.

Delphinium scaposum Greene

Bare-stem larkspur; *espulita cimarrona*. Figure 26.

Herbaceous perennials, from thickened, fibrous-fleshy roots, with 1 to several erect stems 35–60 (85) cm tall, growing during the cooler months of the year, summer dormant. Herbage glabrous or soft pubescent. Leaves mostly in a basal rosette, stem leaves alternate when present; petioles 2–13.5 cm long; blades 2.5–6 cm wide and about as long, with 3–5 deeply cleft and palmately parted broad lobes. Flowering stems with racemes mostly 5–12+-flowered. Flowers pedicelled, showy, bilateral, 2.5–3 cm wide. Sepals 5, deep blue, the upper one forming a prominent spur somewhat longer than the petals. Petals 4, the upper pair forming a nectar-producing spur enclosed by the calyx spur; petals deep blue and white. Filaments dark blue, with thin whitish wings below. Pistils mostly 3, the fruits of many-seeded capsules 12–15 mm long. Flowering March and April.

Widespread in Organ Pipe, especially in the larger mountains, not in the drier, southwestern part on the Monument. Also in the eastern part of Cabeza Prieta. Arroyo margins, hills, and mountains, often on north-facing slopes.

Widespread in Arizona except the southwestern corner, southeastern California, Colorado, Nevada, New Mexico, Utah, and northern Sonora.

Specimens from the flora area were annotated by Michael J. Warnock as *Delphinium parishii* A. Gray subsp. *parishii*, described in 1887. Plants from southwestern Arizona, however, do not seem distinct from *D. scaposum*, described in 1871, and the key characters provided by Warnock (1997) do not serve to distinguish them.

OP: Alamo Canyon, *Nichol 4 May 1939*. Above Dripping Springs, 16 Apr 1952, *Parker 7960*. Near Hwy 85 and road to Alamo Canyon, 30 Mar 1988, *Baker 7603* (ASU). Rocky slope NW of Kino Peak, 1782 ft, 20 Mar 2005, *Rutman 2005-0320-43* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation).

CP: 0.4 mi on Charlie Bell Road W of E boundary of the Refuge, 9 Apr 1993, *Felger 93-309*. S of Charlie Bell Pass, 9 Apr 1993, *Felger 93-336*. Childs Mtn, 2240 ft, 25 Feb 1993, *Felger 93-30*.

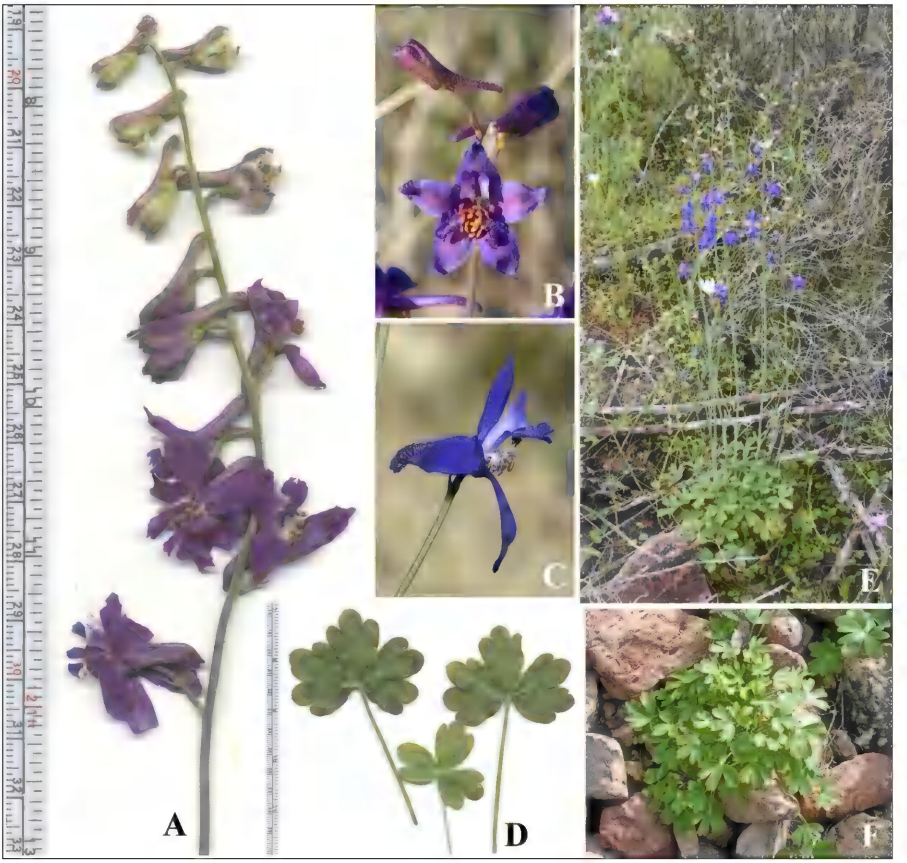

Figure 26. *Delphinium scaposum*. Bull Pasture Trail: (A & D) 7 Mar 2014; (E) 18 Mar 2005; (F) 23 Feb 2009. (B & C) Hat Mountain, Sauceda Mts, 22 Mar 2014.

Myosurus – Mousetail

Dwarf, delicate, short-lived cool-season ephemerals, about 2–10 cm tall. Leaves erect, linear, entire, in a basal rosette. Flowers single on slender scapes, radial, inconspicuous, mostly green, the fruiting receptacle elongated (cylindrical) and spike-like (like a mouse tail), the pistils numerous. (The single flower somewhat resembles the many-flowered spikes of *Plantago*.) Sepals petal-like, usually 5, with a small spur; petals 5 or fewer, and inconspicuous. Stamens 5 to many. Fruits of achenes. On wet or moist soils. Temperate regions worldwide; 15 species.

1. Outer face of achene about as wide as long, appearing swollen, beak of achene 0.6–1+ mm long. ..... **Myosurus cupulatus**
1. Outer face of achene obviously longer than wide, not noticeably swollen, the beak to 0.4 mm long. ..... **Myosurus minimus**

Myosurus cupulatus S. Watson
Mousetail. Figure 27.

Locally in temporarily wet or moist microhabitats in the Ajo Mountains, such as margins of drying, small puddles and arroyo-bottom pools, or at the base of cliffs. It has been part of the Ajo Mountain flora for more than 21,800 years.

Eastern California to Colorado, Texas, Utah, Baja California, and northern Sonora.

OP: Bull Pasture Trail, 2800 ft, 21 Jun 1979, *Bowers 1758* (ORPI; plants dry and dead). Alamo Canyon, *Wirt 13 Mar 1991* (ORPI). S Fork of Alamo Canyon, *Wirt 5 Mar 1998*. Bull Pasture, 10 Apr 2005, *Felger 05-199*. Arch Canyon, *Holm 10 Apr 2012* (specimen discarded). †Montezuma's Head, fruits, 17,830 to 21,840 ybp (3 samples). †Montezuma's Head: receptacle fragment with 2 achenes, 17,830 ybp; achenes, receptacle fragment with achene, 21,840 ybp.

Figure 27. *Myosurus cupulatus*. (A) Catfish Tank, NE Grosvenor Hills, Salero Ranch, Santa Cruz Co., 17 Feb 2014, photo by Sue Carnahan (SEINet). (B) Sycamore Canyon near Cliff, Grant Co., New Mexico, 2 Apr 2010, photo by Russell Kleinman (gilaflora.com). (C) Bull Pasture, 18 Mar 2005.

Myosurus minimus Linnaeus
Dwarf mousetail. Figure 28.

Emergent from shallow water. Leaves 3–8+ cm × 0.4–0.9+ mm. Scapes erect, 3–6.3+ cm long. Spike-like receptacle 15+ × 2.6+ mm. Sepals 1.5–1.6 mm long, the spur 0.5 mm long. Stamens 5. Achenes with a minute, scarcely apparent beak.

Recorded from Quitobaquito when the oasis was owned and managed by the Orozco family. It grew with other small and likewise locally extirpated herbaceous plants requiring open wetland habitat (Felger et al. 1992). No other collections of this species are known from the Monument or nearby regions.

Vernal pools and other wetland habitats; Alaska and Canada, across the USA to Baja California, Eurasia, and Africa.

OP: Quitobaquito, marshy area bordering alkaline pool, with *Poa annua*,18 Mar 1945, *Gould 2986*.

Figure 28. *Myosurus minimus*. (A) Aeromodelers Field, Yolo Co., CA, about 2008, photo by Barry Rice (CalPhotos). (B) Hobro, Nordjylland, Denmark, date unknown, photo by J.C. Schou (BioPix).

††Myosurus nitidus Eastwood
[*M. egglestonii* Wooton & Standley]

This species occurred with *M. cupulatus* more than 21,800 years ago in the Ajo Mountains. The nearest present-day populations are in central Arizona. Also in Colorado and New Mexico, often growing under sagebrush (*Artemisia tridentata* complex).

OP: †Montezuma's Head, receptacle with one dozen achenes, 21,840 ybp.

Thalictrum – Meadow-rue

Nearly worldwide, mostly temperate; 120–200 species.

Thalictrum fendleri Engelmann ex Gray
Fendler's meadow-rue. Figures 29A and B.

Tall slender perennial herbs; glabrous. Stems often purplish. Leaves 2–4 times pinnately divided, the segments lobed or crenate. Male and female flowers on separate plants (dioecious). Stamens numerous, pendulent, with prominent anthers. Female flowers with enlarged brush-like stigmas. Sepals greenish; petals none. Fruits of achenes in clusters about 1 cm long.

Known in the flora area from a single population in a protected microenvironment in the upper reaches of Arch Canyon, along with several other isolated populations of non-desert plants. This is the closest approach to the Sonoran Desert for this primarily temperate plant. The nearest population is in the Baboquivari Mountains. This species is widespread in Western North America.

OP: Arch Canyon, W of Mount Ajo, canyon bottom shaded by steep canyon walls and trees; *Quercus turbinella*, *Sapindus drummondii*, *Frangula betulifolia*, *Morus microphylla*, *Ptelea trifoliata*; *Ribes quercetorum, Rhus aromatic*, *Phacelia ramosissima,* and *Urtica gracilenta*, *Holm & Ryan 29 Mar 2015*.

Figure 29A. *Thalictrum fendleri*. (A) Male flowers, W fork of Oak Creek, N of Sedona, Coconino Co., 25 Aug 2005, photo by Max Licher (SEINet). (B) Reef Campground, Huachuca Mountains, Cochise Co., 8 Aug 2005, photo by Patrick Alexander (SEINet). (C) Garden Canyon, Huachuca Mts, Cochise Co., 19 Aug 2010, photo by Jillian Cowles (SEINet).

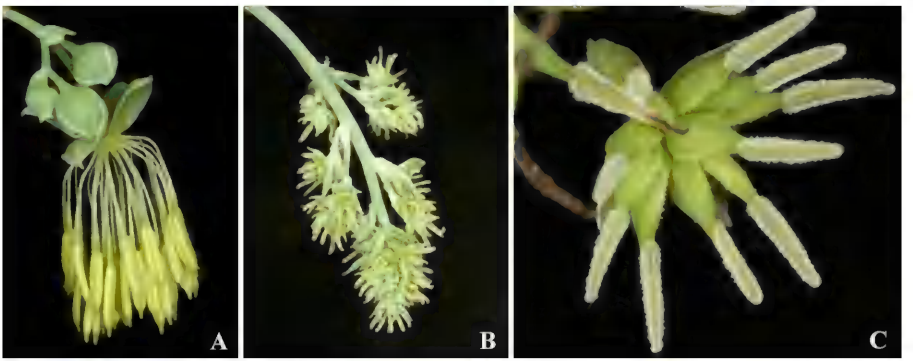

Figure 29B. *Thalictrum fendleri*. Little Cherry Creek Road, Pinos Altos Mountains, Grant Co., NM, photos by Russell Kleinman (gilaflora.com): (A) Male flower, 30 Jun 2009; (B) Female flowers, 30 Jun 2009; (C) female flower, 2 Jul 2009.

RESEDACEAE – Mignonette Family

Northern and eastern Hemispheres; 6 genera, 85 species.

Oligomeris

Western North America and Old World; 3 species.

Oligomeris linifolia (Vahl) J.F. Macbride

Desert cambess. Figure 30.

Ephemerals recorded in the region from October through May; glabrous, (5) 10–40 cm tall. Stems leafy, few-branched or much-branched when well watered, with a well-developed taproot. Leaves alternate or fascicled in densely clustered axillary short shoots; leaves narrowly linear, 1.5–3.5 (4.3) cm × 6–12 mm; stipules bristle-like. Inflorescences of slender, densely flowered spikes. Flowers sessile, moderately bilateral, inconspicuous, green and white. Bracts and sepals fleshy, green with white margins, 1–2 mm long; sepals 4; petals 2, white, 1 mm long. Stamens 3. Fruits of capsules 2.5 (3) mm wide, globose; ovary and capsules gaping open at the top, of 4 swollen carpels each terminating in a broad tooth surmounted by a stigma, the teeth unequal in size. Seeds 0.5–0.6 × 0.45 mm, numerous, shiny black, smooth, and obovoid.

Widespread, mostly at lower elevations; lower slopes, desert plains, pavements, gravelly soils of washes and arroyo beds, sand flats, dunes, and often abundant in playas and at charcos.

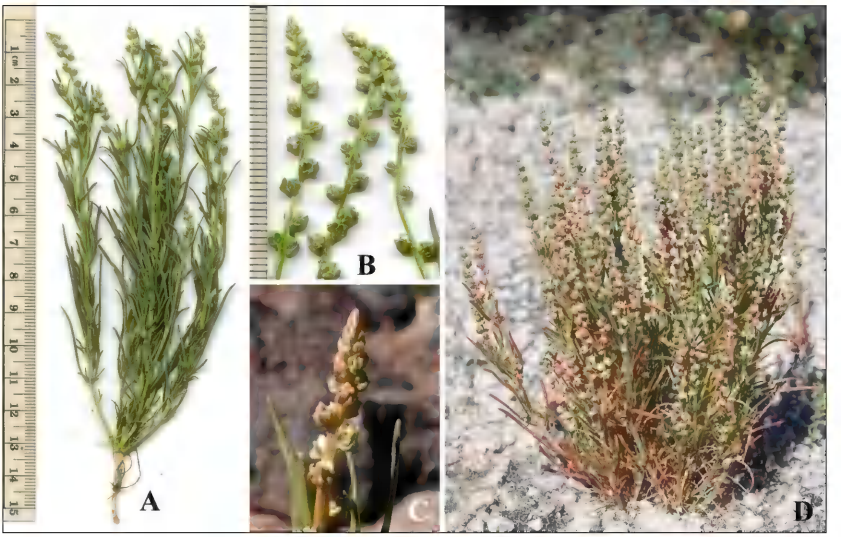

Figure 30. *Oligomeris linifolia*. (A & B) Aguajita Wash near international boundary, 8 Feb 2015. (C) Papago Tanks, Pinacate Biosphere Reserve, Sonora, 24 Feb 2014, photo by Sue Carnahan. (D) Quitobaquito Hills, 25 Feb 2015.

Mostly deserts, also Mediterranean climates; northwestern Mexico and southwestern USA, Africa and the Middle East to India. Although sometimes claimed not to be native in the New World, it is in fact native to the Southwest. The seeds were eaten by the Seris (Felger & Moser 1985) as well as by people living along the shores of ancient Lake Cahuilla (in a reduced phase now the Salton Sea), as shown by Wilke's (1978) analysis of coprolites from prehistoric lakeshore campsites. The Seris parched and ground the seeds, and consumed the flour mixed with water. *Oligomeris linifolia*

also may have been a common food resource on the Baja California Peninsula (Hodgson 2001). Although the seeds are minute, they are often available in substantial quantity. Molecular research by Martín-Bravo et al. (2009) shows that it is native in North America, although representing a remarkable disjunction in the family.

OP: Puerto Blanco Mts, 2000 ft, *Nichol 25 Feb 1939*. Quitobaquito, *Nichol 28 Apr 1939*. Flats N of Bates Mts, 23 Mar 2003, *Rutman 2003-398* (ORPI).

CP: Las Playas, 15 Apr 1941, *Benson 10776*. Pinta Sands, 29 Mar 1970, *Duncan 4*. Papago Well, *Furlow 14 Mar 1979*. Near Tule Well, 21 Mar 1992, *Yeatts 3249* (CAB).

TA: Butler Mts, *Van Devender 27 Mar 1983*. Coyote Water, 25 Oct 2004, *Felger 04-53*. Tinajas Altas Pass, 18 Mar 1992, *Felger* (observation).

RHAMNACEAE – Buckthorn Family

Hardwood shrubs and occasionally small trees (those in the flora area; elsewhere commonly trees and some perennial herbs). Leaves usually alternate, simple, pinnately veined or 3–several main veins from the base; stipules small or modified into spines. Flowers in axillary clusters, radial, and small; bisexual or unisexual, green, yellow, or white, or sometimes pink, usually with a short hypanthium resembling a calyx. Sepals 4 or 5, united at the base, the lobes usually triangular and quickly deciduous. Petals 4, 5, or none. Fruits of fleshy drupes. Worldwide; 50 genera, 950 species.

1. Fruits dry capsules, 3-seeded…….. **Colubrina**
1. Fruits fleshy drupes, 1–3-seeded.

2. Leaves more than 5 cm long and minutely toothed or leaves 2–3 cm long and holly-like with spine-tipped teeth; fruits 2- or 3-seeded; Ajo Mountains.

3. Leaves about twice as long as wide, the margins finely toothed, the teeth not spine-tipped; flowers bisexual, 5-merous; drupes at first red, blackish or purplish when ripe, usually 3-seeded. …….. **Frangula**
3. Leaves about as wide as long, the margins with spine-tipped teeth; flowers unisexual, 4-merous; drupes bright red, usually 2-seeded…….. **Rhamnus**

2. Leaves less than 2.5 cm long, the margins entire or teeth few and not spine-tipped; fruits 1-seeded; widespread including the Ajo Mountains.

4. Leaves spatulate, widest well above middle; fruits 3–4.5 mm long, the surfaces not glaucous. …….. **Condalia**
4. Leaves ovate to narrowly elliptic, widest from well below to middle of leaf; fruits 8–10 mm long, the surfaces glaucous…….. **Ziziphus**

Ceanothus

North America; 55 species of shrubs.

††**Ceanothus vestitus** Greene

[*C. greggii* var. *vestitus* (Greene) McMinn]
Mojave ceanothus

Rigidly-branched shrubs. The leaf is distinctive — thick and with a cellular pattern of venation.

Ceanothus vestitus is documented for the Ajo Mountains from 9600 to more than 29,000 years ago. This is a typical chaparral plant of sub-Mogollon Arizona above the desert, 3000–7000

feet. The nearest present-day populations of *C. vestitus* are in southern Arizona in the Santa Rita and Superstition mountains.

California to Nevada, Utah, southwest Texas, Baja California, and perhaps northern Sonora (see Currie & Ayers 2006). The fossils, especially the older ones, may instead be the closely related *C. pauciflorus* de Candolle [*C. greggii* A. Gray], which occurs in north-central Mexico (Currie & Ayers 2006).

OP: †Alamo Canyon, leaves, 9570 to 29,110 ybp (3 samples).

Colubrina californica I.M. Johnston
[*C. texensis* (Torrey & A. Gray) A. Gray var. *californica* (I.M. Johnston) L.D. Benson]
Large drought-deciduous shrubs with small whitish flowers.

Benson and Darrow (1945) reported it for the Ajo Mountains but no specimen has been located. The nearest known populations are nearby in hills south of Sonoyta (Felger 2000) and in the Sauceda Mountains (e.g., 2 km S of Thanksgiving Day Tank, *Felger 02-141*).

Arizona and southeastern California, both Baja California states and western Sonora.

Condalia
Hardwood shrubs, Americas; 18 species.

Condalia globosa I.M. Johnston var. **pubescens** I.M. Johnston
Desert snakewood; *crucillo*; kawk kuavulĭ. Figure 31.
Shrubs or small trees often 2–4 m tall, with very hard wood. Densely branched, sometimes with short, thick trunks and lower limbs; twigs mostly thorn-tipped. Partly evergreen to gradually deciduous in drought; larger leaves petioled, quickly drought deciduous, the smaller leaves subsessile. Leaves spatulate, 3.3–22 × 1.5–4 mm, crowded on very short spur-branches (short shoots), the margins entire. Lower leaf surfaces with conspicuous raised veins, the upper surfaces with the midrib concave; lower surface of young leaves often yellowish with minute, glistening golden glands. Flowers in small clusters at short shoots. Pedicels slender, 2.7–6 mm long. Flowers yellowish green, 3 mm wide, the disk at anthesis awash with sticky glistening nectar. Calyx tube broad and very short, with a flat disk and 5 lobes; petals none. Fruits globose, dark brown or blackish, 3–4.5 mm long plus a persistent style 0.5 mm long; disk at base of fruit 2 mm wide. Flowering en mass during warmer months, especially following summer rains; fragrant and attracting hoards of insects.

Banks and streamways of large arroyos and canyons; widespread in Organ Pipe and the northeastern part of Cabeza Prieta. Larvae of the saturniid moth *Agapema anona* feed on condalia and spongy masses of their cocoons are often seen among the thorny branches.

Condalia globosa ranges from southeastern California and southwestern Arizona to northwestern Sinaloa and through the Baja California Peninsula. Apparently only var. *pubescens* occurs in the northernmost part of the range and only var. *globosa* occurs in the southernmost part (e.g., south of Guaymas, Sonora).

Condalia fossils resembling *C. globosa* were in the Tinajas Altas Mountains 9000 to 11,000 years ago, and this species or perhaps the related *C. warnockii* M.C. Johnston was in the Puerto Blanco Mountains 9700 years ago. The nearest present-day *C. warnockii* shrubs are in the Sauceda Mountains in the Goldwater Gunnery Range.

Figure 31. *Condalia globosa* var. *pubescens*. (A) Estes Canyon, 14 Aug 2013. (B) Ironwood Hills & Silverbell Road, Tucson, 12 Jun 2010, photo by Ries Lindley. (C) Ajo Scenic Loop, Little Ajo Mts, 31 Jul 2014. (D) Chico Suni Wash near Chico Suni Village, 30 Oct 2014. (E) Kuakatch Wash near E boundary of Organ Pipe, 3 Mar 2014.

Tree-sized condalias were once more common (e.g., *Peebles 14329*; Felger et al. 2001). Many of the larger condalias, especially in nearby Sonora in the Sonoyta region and near Ajo, have regrown from axe-cut large stumps. The plants are slow growing. The wood is attractive when worked, and was locally called rosewood and used to make items such as paperweights and pistol grips (Simmons 1966). The thin, fleshy part of the small fruits was eaten fresh, probably serving as a minor resource (Castetter & Bell 1942; Hodgson 2001). In 2003 Jim Malusa found the tallest

recorded specimen—it was in the Little Ajo Mountains and measured 5.5 m tall with a crown 7.6 m across, and the trunk 112 cm in circumference (American Forests 2013).

OP: Bates Well, *Nichol 26 Apr 1939*. 20 mi SE of Ajo, "common in the vicinity of Sonoita, Sonora, and there attains a height of about 20 feet," 6 May 1939, *Peebles 14329*. Pitahaya Canyon, *Nichol 23 Feb 1939*. Quitobaquito, 5 Mar 1940, *Peebles 14557*. Dripping Springs, 18 Mar 1945, *Darrow 2447*. Headquarters, 5 May 1949, *Supernaugh 438*. Aguajita Spring, 23 Oct 1987, *Felger 87-274*. †*C. globosa* or *C. warnockii*: Puerto Blanco Mts, on ridge, seeds, 9720 ybp.

CP: 2 mi N of Corner Well (Simmons 1966). Packrat Hill, 25 Feb 1993, *Felger 93-60*. Charlie Bell Rd, 1 km W of E boundary of Refuge, 5 Mar 1994, *Felger 94-21*. Daniel's Arroyo in Charlie Bell area, tree, 1310 ft, 22 Nov 1998, *Harlan 529*.

TA: †*C.* cf. *globosa*: Tinajas Altas, seeds, 8970 & 10,950 ybp.

Frangula

Shrubs and small trees, North America and Eurasia; 50 species. A genus segregated from *Rhamnus*.

Frangula betulifolia (Greene) Grubov
[*Rhamnus betulifolia* Greene]
Birchleaf buckthorn; *salicieso*. Figure 32.

Shrubs or small trees to 8 m tall; bark smooth. Leaves winter deciduous, alternate, 6–10 cm long; petioles short; leaf blades oblong to elliptic, relatively thin, dark green, and pubescent on both surfaces when young, margins more or less serrated. Inflorescences of small axillary cymes much shorter than the leaves; flowering with new leaves in spring. Flowers 5-merous, pedicellate; sepals 1–2 mm long, yellow, and triangular; petals 1 mm long, pale yellow, becoming brownish with age. Drupes purplish-black when ripe, spherical, 0.5–1 cm wide, glabrous, and with (2) 3 (4) seeds.

Figure 32. *Frangula betulifolia*. (A) C Bar Ranch Road, Burro Mountains, Grant Co., NM, photo by Russell Kleinman (gilaflora.com). (B) Little Cherry Creek Road, Piños Altos Mountains, Grant Co., NM, photo by Russell Kleinman (gilaflora.com). (C) Sierra el Tigre, Sonora, 10 Aug 2015, photo © by Sky Jacobs (SEINet).

Small, isolated populations grow in the Ajo Mountains at higher elevations in protected, shaded canyons and their north-facing slopes, especially at cliff bases. This decidedly non-desert plant ranges no closer to the Sonoran Desert.

Eastward in mountains in southern Arizona, New Mexico, west Texas, and Sonora to Durango, Tamaulipas, and Nuevo León (Nesom & Sawyer 2009).

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. N-facing slopes of the arch in Arch Canyon, 900 m, desertscrub with *Vauquelinia* and *Dodonaea*, 2 Dec 1990, *Felger 90-542*.

Rhamnus

Shrubs and trees, nearly worldwide; 110 species.

Rhamnus crocea Nuttall, 1838

[*R. ilicifolia* Kellogg, 1863. *R. crocea* var. *ilicifolia* (Kellogg) Greene, 1891. *R. crocea* subsp. *ilicifolia* (Kellogg) C.B. Wolf, 1938]

Hollyleaf buckthorn, hollyleaf redberry. Figure 33.

Woody shrubs to small trees, with rigid branches. Leaves 2–3 cm long, alternate, essentially evergreen, petioled and holly-like, the leaf blades obovate to ovate or orbicular, glabrous with spinescent, toothed, or entire margins. Flowers on 1–few-flowered axillary cymes much shorter than the leaves. Flowers pedicelled, unisexual, 4-merous, small and yellow-green; sepals 4, greenish-yellow, and triangular; petals none; flowering March and April. Stamens 4. Fruits of fleshy, globose red drupes to about 5 mm wide with 2 seeds.

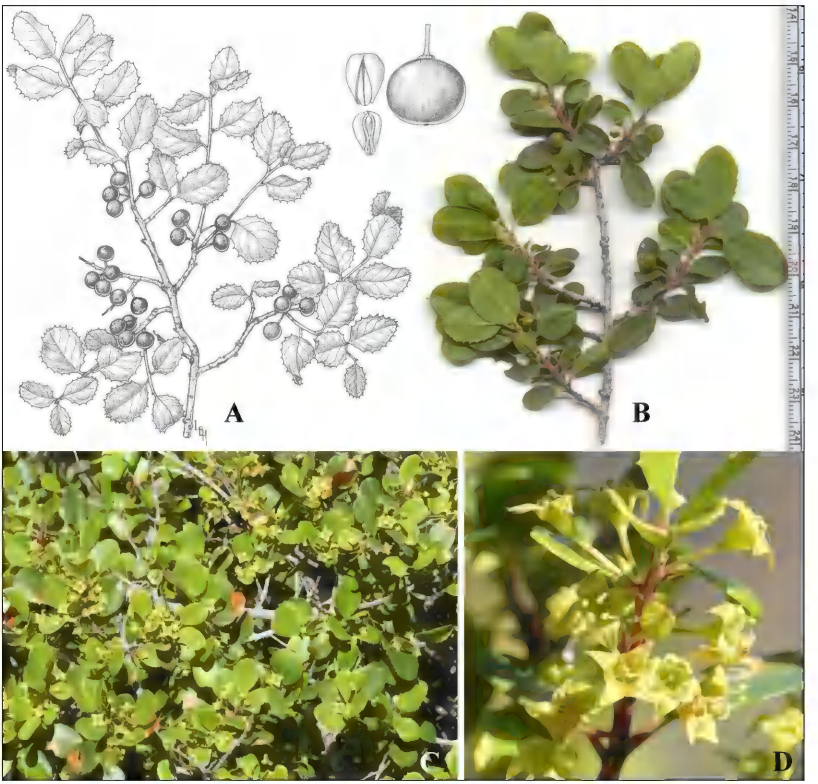

Figure 33. *Rhamnus crocea*. (A) By Lucretia Breazeale Hamilton. (B) Middle fork of Alamo Canyon, 24 Mar 2008. (C & D) Bull Pasture, 5 Apr 2010.

Ajo Mountains canyon bottoms and north-facing slopes at middle and high elevations (above 2800 ft), often growing with *Juniperus*, *Quercus*, and *Vauquelinia*.

Generally in chaparral and oak woodland; western and southern Arizona, and southeastern Oregon to Baja California, and Nevada.

Neal (2006) mapped both *Rhamnus crocea* and *R. ilicifolia* in Organ Pipe. In the identification key *R. crocea* is separated by having smaller leaves and entire or toothed margins, and *R. ilicifolia* is distinguished by larger leaves with spinescent margins. Both leaf forms can be found on the same plant among the Ajo Mountain population. The older of the two names is chosen here. In California, where the two are sympatric over a relatively broad region, *R. crocea* is distinguished from *R. ilicifolia* in its essentially non-thorny branches and smaller leaves with less spinose margins. The variation may be environmentally related rather than genetic.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, 2500 ft, 17 Mar 1952, *Parker 8001*. Boulder Canyon, 2800 ft, 3 May 1978, *Bowers 1292*. Bull Pasture Trail, 3000 ft, 5 Apr 1978, *Bowers 1210*. Arch Canyon, 2 Dec 1990, *Felger 90-546*.

Ziziphus

Trees, shrubs, and vines. Nearly worldwide, mostly tropics and subtropics; 100 species. Some Old World species, both tropical and temperate, are important fruit trees.

Ziziphus obtusifolia (Hooker ex Torrey & A. Gray) A. Gray var. **canescens** (A. Gray) M.C. Johnston
[*Condalia lycioides* (A. Gray) Weberbauer var. *canescens* (A. Gray) Trelease]
Lotebush, white crucillo, graythorn; *abrojo*. Figure 34.

Spinescent, messy-looking sprawling shrubs to 2+ m tall, with rigid branches forming dense, thorny tangles. Stems gray-green, the twigs thorn-tipped and commonly spreading at right angles. Young branches, leaves, inflorescences, pedicels, and exposed portions of buds densely pubescent with short spreading white hairs; twigs and branches glabrate with age. Leaves sparse and quickly drought deciduous, the shrubs often nearly leafless; leaves alternate on long shoots and in several-leaved fascicles on short shoots, the blades triangular-ovate to narrowly elliptic, mostly 8–22 mm long, the midrib prominent, the lateral veins pinnate, the margins entire or with a few small teeth, especially on long-shoot leaves. Leaf edges are often chewed by insects and at first glance might not appear entire. Flowers in axillary sub-umbellate clusters usually less than 1 cm long. Basal disk of flowers and fruits semi-persistent. Flowers 2.5–3 mm wide. Sepal lobes broadly triangular, surrounding a flat disk. Petals white, clawed, sticking out laterally from not quite open flowers, later loosely enfolding the stamens and quickly falling after the anthers mature (petals often gone by the time the stigma expands). Fruits of fleshy drupes, 8–10 mm long, blackish blue to purple-brown, the pericarp thin, fleshy, and edible and slightly sweet. Flowering at least May–September, the flowers visited by honeybees, native bees, large orange-winged spider wasps (*Pepsis* or *Hemipepsis*), and other insects.

Mostly along washes and canyons. Widespread in Organ Pipe, Cabeza Prieta especially in the eastern part, and also at Tinajas Altas. It has been in the Tinajas Altas Mountains for at least 8700 years.

Variety *canescens* mostly in the Sonoran Desert: southeastern California, southern Nevada, and western and southern Arizona to southern Sonora, and both Baja California states. Var. *obtusifolia* is mostly in the Chihuahuan Desert Region.

The fleshy parts of the fruits were eaten fresh or cooked (Rea 1997) and the Seris obtained sizable quantities of the fruit from packrat nests (Felger & Moser 1985). Among the O'odham the fleshy fruits were boiled to a syrup like that of cactus fruits and the juice was sometimes fermented (Castetter & Underhill 1935).

OP: Bates Well, *Nichol 26 Apr 1939*. Alamo Canyon, 27 Mar 1976, *Scaggs 2072*. Aguajita, 19 Jun 1989, *Felger 89-233*. N of Quitobaquito Pond, hypersaline soils with underground water from Quitobaquito Springs, bosque around pond, 15 Jun 2013, *Rutman 20130615-4*.

CP: E side of Pinacate lava flow (Simmons 1966). Tule Well, 14 Apr 1992, *Harlan & Steinmann 283* (CAB). Daniels Arroyo at Charlie Bell Rd, Heart Tank, Tule Well, 12–16 Jun 1992, *Felger* (observations). Las Playas, playa mesquite thicket, 210 m, 24 Nov 1994, *Harlan 445*.

TA: Tinajas Altas, broad wash immediately E of the tinajas, 20 Nov 2008, *Felger 08-170*. †Tinajas Altas, twigs, 1230 to 8700 ybp (3 samples).

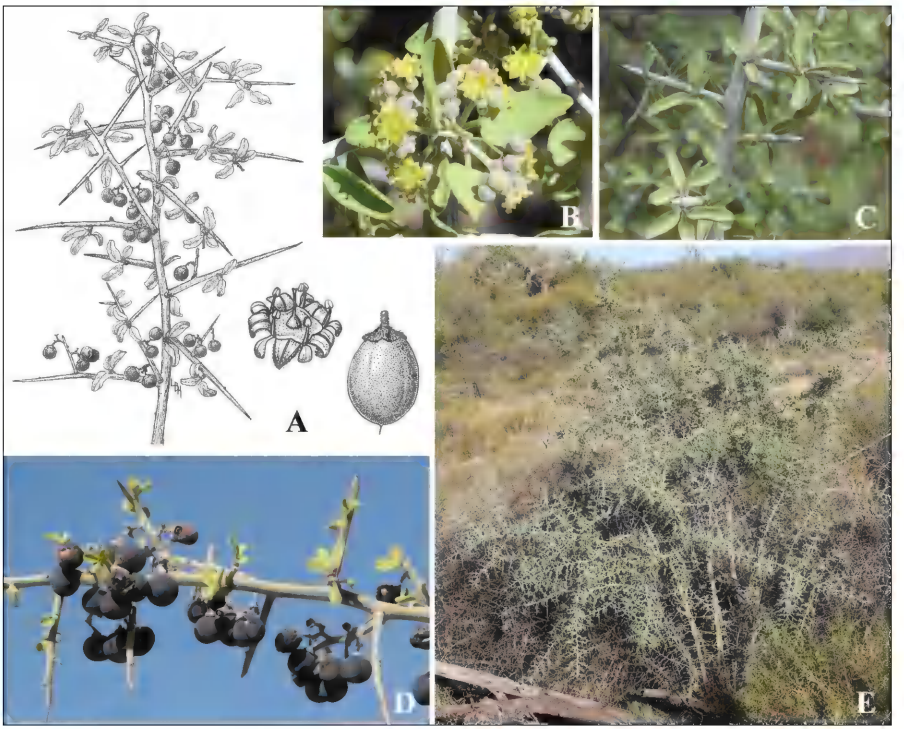

Figure 34. *Ziziphus obtusifolia* var. *canescens*. (A) By Lucretia Breazeale Hamilton. (B) Aguajita Wash near Aguajita Spring, 18 Mar 2015. Quitobaquito: (C) 17 Jul 2013; (D) 14 May 2006; (E) 23 Sep 2014.

(RIVINACEAE) **PETIVERIACEAE**

Herbs to trees or lianas; warm regions of the New World, Australia, New Hebrides and New Caledonia; 9 genera, 13 species. *Rivina*, formerly included in Phytolaccaceae or Rivinaceae, is more recently placed in the Petiveriaceae (Stevens 2012).

Rivina

This genus has a single species.

Rivina humilis Linnaeus

Rouge plant, pigeon berry; *chile de coyote*. Figure 34.

Bushy perennials, scarcely woody at the base, often reaching 1+ m tall, and often growing through other shrubs; growing and flowering with warm to hot weather, the plants frost-sensitive. Stems slender and brittle. Herbage reddish green. Leaves alternate, often 4–12 cm long, simple and entire, ovate, thin, and quickly wilting. Inflorescences of terminal racemes often 4–8 cm long. Flowers white or pink, 4–5 mm wide; sepals 4; petals none; stamens 4. Fruits 3–4 mm in diameter, fleshy, red-purple, and yielding a red dye.

Canyons in the Ajo and Diablo mountains, especially at higher elevations.

Southern and central Arizona to Florida, Baja California Sur and Sonora to South America, the Caribbean, and Africa (introduced?); also widely introduced elsewhere and often cultivated as an ornamental plant. There are numerous references of this species thriving in remarkably deep shade as well as full sun. Although some authors report that the fruits are edible (e.g., Pennington 1963, Standley 1920–1926), others report the fruit to be toxic to humans (e.g., Austin 2004, 2010; Nellis 1997).

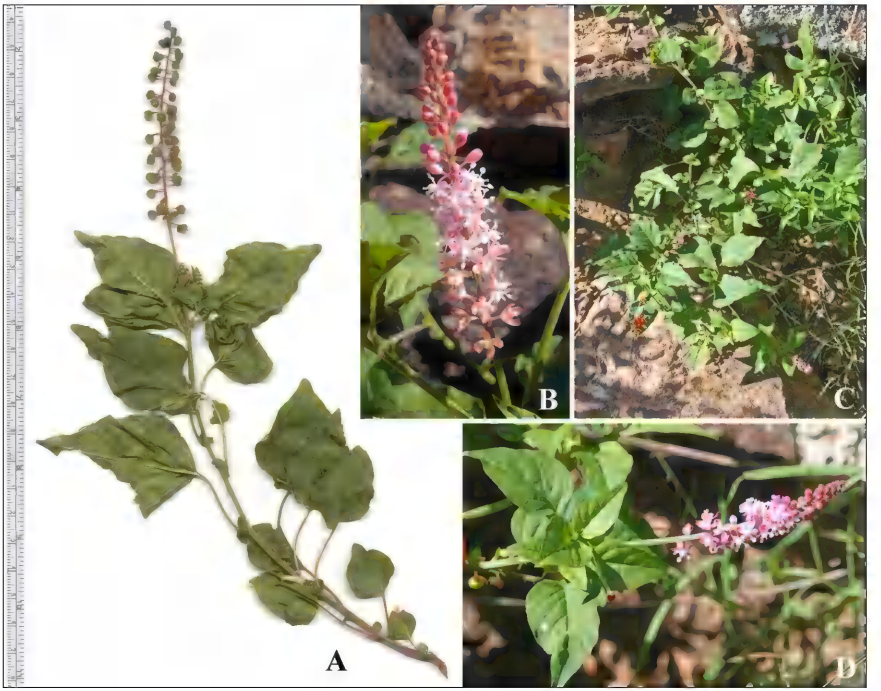

Figure 35. *Rivina humilis*. (A, C & D) Arch Canyon, 16 Sep 2006. (B) SE slope of Poorwill Hill, Salero Ranch, Santa Cruz Co., 29 Jul 2013, photo by Sue Carnahan (SEINet).

OP: Alamo Canyon, 13 Sep 1941, *Goodding 294-41*. Canyon Diablo, 15 Apr 1951, *Supernaugh 430* (ORPI). Below arch in Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-509*.

ROSACEAE – Rose Family

Herbs to trees, worldwide; 110 genera, 3000 species.

Vauquelinia

Shrubs and trees. Southwestern USA and northern Mexico; 2 species.

Vauquelinia californica (Torrey) Sargent subsp. **sonorensis** W.J. Hess & Henrickson
Sonoran rosewood. Figure 36.

Hardwood shrubs and trees. Multiple-stem large shrubs often 3–4 m tall at higher elevations on open slopes and trees in riparian canyons. A tree in Alamo Canyon measured 14.3 m in height with an average crown spread of 12.2 m, and a trunk 2 m in circumference at 1.4 m above ground level (American Forests 2013), as the largest individual in the genus. Herbage with short crinkled to matted hairs. Leaves evergreen and alternate; petioles 3–8 mm long; leaf blades firm (sclerophyllous), linear to linear-lanceolate or narrowly oblong, (3) 5–12 cm × 5–11 mm, markedly bicolored, white-woolly below and dull green and generally glabrate above, the margins thickened, sub-entire to mostly finely toothed.

Inflorescences of terminal, flat-topped compound corymbs often 4 cm wide. Pedicels, floral cups, calyx lobes, and fruits with small, woolly hairs. Flowers 1 cm wide; sepals and petals each 5, the petals white. Fruits of capsules, 4.5–6.5 mm long, firm and woody at maturity, with 5 carpels united below and separate above, each with 2 seeds; seeds with a terminal wing. Flowering May–August.

Canyons and upper elevations in the Ajo Mountains and locally at upper elevations in the Diablo and Puerto Blanco mountains. In Alamo Canyon growing with *Quercus* and *Sapindus*, and at higher elevations often with *Dodonaea viscosa* and *Frangula betulifolia*.

This species has been part of the flora of the Ajo Mountains for at least 13,500 years; these fossils closely resemble subsp. *sonorensis*. For example, specimens 8600 years old have dense pubescence of white, curly-tangled and crinkled hairs on the lower surfaces along the midrib and blade, which is diagnostic for this subspecies. Most of the fossil specimens consist of midribs with a bit of blade tissue, as if the rest was eaten by the packrat collectors.

This subspecies also occurs in the Saucedo and Sand Tank Mountains, the Sierra Cubabi south of the Ajo Mountains in Sonora, and mountains in Baja California. Populations in neighboring regions such as the Baboquivari Mountains have plants with some leaves that may approach subsp. *sonorensis* in shape and color. This species, with four subspecies, ranges from central Arizona and northern Sonora to Baja California Sur, and New Mexico to Durango and Coahuila (Felger et al. 2001; Hess & Henrickson 1987).

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Summit of Bull Pasture Trail, 3500 ft, *Cummins 11 Oct 1976*. Arch Canyon, 850 m, 2 Jun 1978, *Hess & Wilhelm 4259* (holotype of subsp. *sonorensis*, MOR; isotype NY). Alamo Canyon, 2500 ft, 13 Jun 1978, *Bowers 1341*. N-facing slopes below the arch of Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-543*. Puerto Blanco Mts, occasional on steep rocky slopes, upper elevations NW of Pinkley Peak, *Rutman 24 Mar 2001* (ORPI). Along bases of cliffs in upper watershed of Diablo Canyon, Diablo Mts, 3000 ft, *Tibbitts 6 Mar 2003*. †Alamo Canyon, leaf fragments, fruits, 8130 to 9570 ybp (3 samples). †Montezuma's Head, leaves, 13,500 ybp.

Figure 36. *Vauquelinia californica* subsp. *sonorensis*. (A) Alamo Canyon, 13 Mar 2005. (B) Estes Canyon, 14 Aug 2013. (C & D) Boulder Canyon, 24 Sep 2007.

RUBIACEAE – Madder Family

Annuals, perennial herbs, vines, shrubs, and trees. Worldwide; 500 genera, 6000 species.

Galium – Bedstraw

Annual or perennial herbs, or shrubs. Stems slender, square at least when young. Leaves opposite and decussate, whorled, with 4 (2 leaves and 2 leaf-like stipular appendages) or more leaves per node. Flowers small, radial, 4-merous, bisexual or unisexual. Calyx minute or absent; corollas rotate, deeply 4-parted. Ovary inferior. Fruits 2-lobed, 2-seeded, dry or fleshy, indehiscent, sometimes bristly or hairy. Worldwide; 650 species.

1. Small shrubs, larger stems woody and firm; leaf tips sharp-pointed; hairs on ovaries and fruits dense, straight, and longer that the fruits; widespread…… **Galium stellatum**
1. Annual or perennial herbs with delicate, weak stems; leaves not sharp-tipped; ovaries and fruits with few tubercles or very short hairs, or the hairs longer and hooked; Ajo Mountains.

2. Ephemerals; leaf midrib green, the margins not white-edged; ovaries and fruits covered with white, spine-like hooked hairs, these often about as long as fruit width…… **Galium aparine**
2. Perennials; leaves with white margins and midrib; ovaries and fruits with few blunt tubercles or very short, thick hairs (not hooked) much shorter than the fruits…….. **Galium microphyllum**

Galium aparine Linnaeus
Stickywilly, goose-grass bedstraw. Figure 37.

Cool-season ephemerals with delicate, often trailing or scrambling stems; herbage notably scabrous, clinging to clothing by small hooked (retrorse) hairs. Stems to more than 50 cm long. Leaves 6–8 per node, 15–30 mm long, with a mucronate tip, the lower (earlier) leaves spatulate and petioled, the upper (later) leaves linear-oblanceolate and sessile. Flowers small, few on leafy lateral branchlets, bisexual; corollas rotate, 1.6–1.8 mm wide, the lobes acute or obtuse, white or yellowish. Fruits with hooked hairs usually shorter the fruit body.

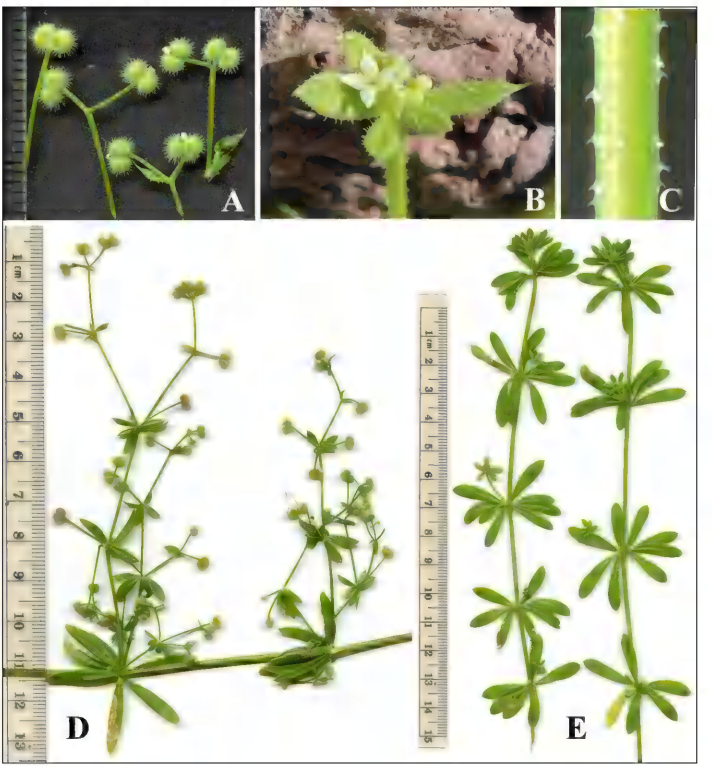

Figure 37. *Galium aparine*. Alamo Canyon: (A & D) 4 Apr 2014; (B & C) 26 Feb 2014; (E) 4 Feb 2015.

Recorded in the Ajo, Bates, and Diablo mountains, especially at higher elevations, canyons, and north-facing slopes.

Widespread in Arizona mostly above the desert; across the USA, Baja California, and the Sierra Madre Occidental in Chihuahua and Sonora.

OP: Canyon Diablo, 21 Mar 1935, *Kearney & Peebles 10845*. Alamo Canyon: *Tinkham 18 Apr 1942*; 29 Mar 2003, *Felger 03-401*. Canyon NW of Kino Peak, 2000 ft, 20 Mar 2005, *Rutman 2005-0320-34* (ORPI).

Galium microphyllum A. Gray
Bract-leaf bedstraw. Figure 38.

Perennial herbs, tufted and somewhat woody at the base; stems to 40 cm long; glabrous or sparsely pubescent, the hairs not hooked. Leaves 4 per node, less than 1 cm long, linear or sometimes ovate, sharp-pointed; margins thick and light-colored. Flowers solitary at nodes or on several-flowered branchlets; bisexual, sessile and in 4-leaved involucres, corollas rotate, 2–2.5 mm wide, the lobes ovate, spreading, and greenish or white; flowering at least in July and August. Fruits granulated or tuberculate, not hairy.

Figure 38. *Galium microphyllum*. Upper Fresno Canyon, Salero Ranch, Santa Cruz Co., 22 Apr 2015, photos by Sue Carnahan (SEINet).

Ajo Mountains, canyon bottoms and "rocky slopes and in shade of boulders" (Bowers 1980: 43).

Arizona to Texas, mostly at elevations above the desert, and Sonora mostly the eastern part, Chihuahua, and Baja California Sur.

OP: Arch Canyon, *anonymous 14 Jan 1965* (ORPI). Alamo Canyon, S fork *Van Devender 31 Aug 1978* (ORPI); 29 Mar 2003, *Felger 03-415*.

Galium stellatum Kellogg
[G. *stellatum* var. *eremicum* Hilend & J.T. Howell]
Starry bedstraw. Figure 39.

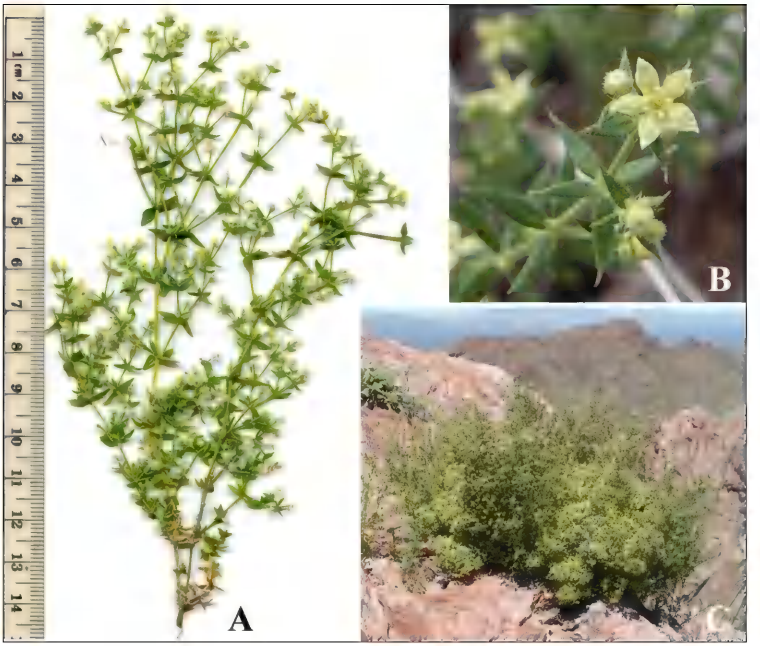

Figure 39. *Galium stellatum*. (A) Alamo Canyon, 4 Apr 2015. (B) Male flower, Wild Burro Canyon, Tortolita Mts, Pima Co., 24 Mar 2013, photo by Sue Carnahan. (C) Trail to Mount Ajo, 26 Mar 2005.

Dense to open, untidy and irregular-shaped small shrubs or subshrubs, reaching 50–80 cm tall. Stems slender, brittle, and square in cross-section with white-margined corners. Leaves and young stems scabrous with short white hairs. Vegetative or long-shoots woody with long internodes and brittle perennial stems forming the framework of the plant, with peeling, stringy bark and relatively large leaves, the old dry leaves whitish and often persisting. Fertile or short-shoots bunched at nodes of the long shoots, with very short internodes, dying back or deciduous during drought, and with slender and relatively flexible stems and small leaves. Leaves sessile, ovate to lanceolate, narrowed to a subspinose tip, short- and long-shoot leaves mostly 2–8 (10+) × 0.8–3 mm; lower leaf surfaces with a prominent white midrib and moderately inrolled margins. Male and female flowers

on separate plants. Flowers in small leafy panicles among the short shoots. Corollas 2.5–3 mm wide, whitish to pale yellow with purplish net-like veins. Ovaries and fruits densely covered with spreading, straight silky white hairs, the hairs longer than the fruit. Fruits dry, 3–5 mm wide including the hairs. Flowering in spring.

Widespread across the region in granitic and volcanic ranges; usually north- and east-facing slopes among rocks and along canyons, and in the more arid mountains especially toward higher elevations. *Galium stellatum* has been a part of the local flora for at least 18,700 years.

Mostly in desert mountains; western and southern Arizona, southwestern Utah, southern Nevada, southeastern California to northern Baja California Sur, and northern Sonora. *Galium stellatum* is the shrubbiest of all the New World galiums.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. Alamo Canyon, 12 Apr 1978, *Bowers 1251*. Canyon NW of Kino Peak, 2000 ft, 20 Mar 2005, *Rutman 2005-0320-33* (ORPI). †Alamo Canyon, twigs, leaves, seeds, 9570 ybp. †Montezuma Head, leaf, fruit (with long straight hairs papillate at their bases), 21,840 ybp.

CP: Tule Tank, 26 Mar 1932, *Shreve 5937*. E side Sierra Pinta, 28 Mar 1957, *Monson 8*. Agua Dulce Spring canyon, 13 Apr 1964, *Niles 340*. Cabeza Prieta Mts, *Van Devender 9 Mar 1980*. Christmas Pass, 13 Apr 1992, *Harlan & Steinmann 275* (CAB). Sierra Arida, 1595 ft, W slope below summit, 18 Mar 1992, *Yeatts 3254* (CAB).

TA: Tinajas Altas, 29 Mar 1930, *Harrison & Kearney 6574*. 1 mi N of Tinajas Altas, 17 Apr 1948, *Kurtz 1153*. †Tinajas Altas, stems, leaves, fruits, 4010 to 18,700 ybp (13 samples).

RUTACEAE – Rue or Citrus Family

Unarmed shrubs or small trees (those in the flora area; also perennial herbs elsewhere), gland-dotted and aromatic (with essential oils). Leaves alternate, simple or compound; without stipules. Flowers in short panicles or racemes, unisexual or bisexual, radial, and with a disk, the sepals and petals each 4 or 5. Worldwide; 158 genera, 1900 species.

1. Leafy shrubs, the leaves with 3 broad leaflets; Ajo Mountains..... **Ptelea**
1. Leafless or sparsely leafy shrubs, the leaves simple, linear or scale-like; arid slopes in Cabeza Prieta and Tinajas Altas..... **Thamnosma**

Ptelea

Shrubs or sometimes small trees. USA and Mexico; 3 species.

Ptelea trifoliata Linnaeus
Hop tree. Figure 40.

Slender shrubs or small trees to 4 (8) m tall, the younger stems shiny reddish brown with prominent lenticels. Leaves aromatic with a citrus- or skunk-like fragrance when crushed; winter deciduous, alternate, shiny and glabrous or glabrate; petioled, the leaflets three, thin, and gland-dotted, the terminal one largest, 3.5–10 × 1.5–5 cm, lanceolate to obovate, the lateral leaflets unequal, the margins minutely toothed or entire. Flowers in small terminal panicles, bisexual and unisexual, with citrus-like fragrance, fly pollinated, greenish white, 4- or 5-merous, 11–15 mm wide, the sepals 1–2 mm long, the petals 4–5 mm long. Flowering March and April. Fruits of thin, papery, disc-shaped, wind-dispersed samaras 1–2.3 cm wide, with a conspicuously veined broad encircling wing. Fruits ripening around July.

Ajo Mountains, canyons and rocky slopes, above and at the upper edge of the desert; this is the closest that hoptree comes to the desert.

Arizona, mostly above the deserts. Canada to southern Mexico with five subspecies and 12 varieties of doubtful merit; southern Arizona populations are subsp. *angustifolia* (Bentham) V.L. Bailey.

OP: Alamo Canyon: *Harbison 13 Dec 1939* (SD); 3800 ft, *Tinkham 20 Apr 1942*. Arch Canyon, 1 Apr 1976, *Skaggs 212* (ARIZ, ASC). Above Pitahaya Canyon, 1180 m, base of N-facing cliffs, foliage with odor of skunk, trees to 8 m tall, 25 Mar 1990, *Baker 7782* (ASU, ORPI). Arch Canyon, 915 m, tree to 4 m tall, old bark light gray, smooth with lenticels, young shoots red-brown, 12 May 1988, *Baker 7610* (ASU). Estes Canyon, *Pate 19 Nov 1994* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, slender tree-like 2.5+m tall, leaves stinky, shiny green, flowers cream colored, 10 Apr 2005, *Felger 05-264*.

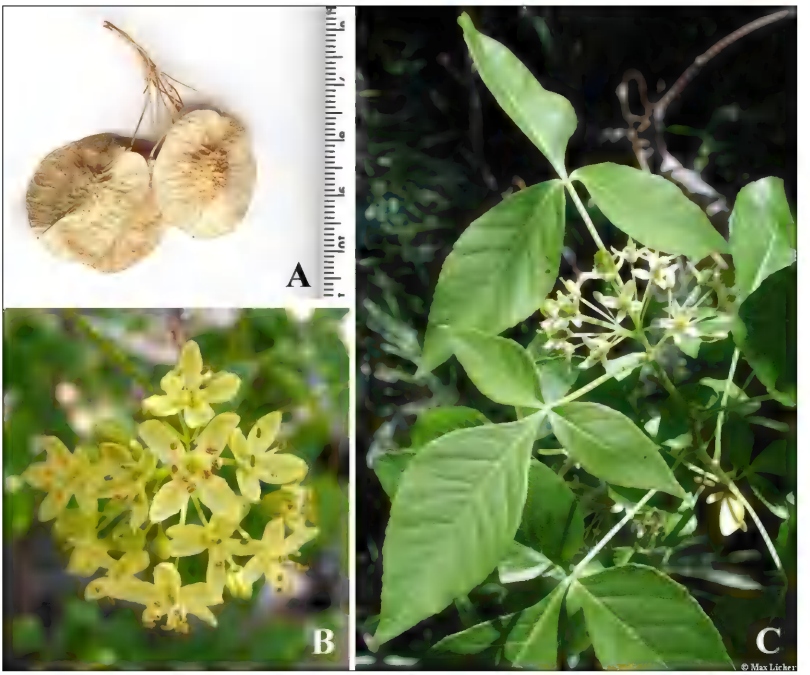

Figure 40. *Ptelea trifoliata*. (A) Trail to Woods Canyon, near Chiricahua National Monument, Cochise Co., 3 Jun 1975, *Reeves R-2980* (ASU). (B) Florida Canyon, Santa Rita Mountains, Pima Co., 5 Apr 2015, photo by Sue Carnahan. (C) West Fork of Oak Creek Canyon, Coconino Co., 25 Apr. 2001, photo by Max Licher (SEINet).

Thamnosma

Subshrubs and shrubs. Southwestern USA, northern Mexico, and southern Arabia to southern Africa; 12 species.

Thamnosma montana Torrey & Frémont

Turpentine broom. Figure 41.

Small aromatic shrubs, often almost leafless. Stems strangely yellowish green. Herbage and flowers stinky, or new growth often lemon-like when crushed; densely dotted with donut-shaped

glands 0.3–0.4 mm wide. Leaves alternate, sparse and quickly shed, linear or narrowly spatulate, 6–23 × 0.8–1.2 mm, reduced above to scales. Inflorescences of few-flowered raceme-like branches near stem tips, or flowers solitary in axils. Flowers bisexual, about 1 cm long, glistening dark indigo-blue (sepals, petals, and stamens), contrasting spectacularly with the stems. Sepals 4, short and thick. Petals 4 and thick. Flowers protogynous—the style and stigma protrudes from the unopened flower, then the corolla opens and the filaments elongate and the anthers open and shed pollen. Flowers stinking at midday, visited by large syrphid flies and honeybees (the bees vigorously stick their head into the corolla, forcing apart the petals to get inside). Flowering January to April, and fruiting in the same season. Fruits tough and leathery, of 2 inflated, gland-dotted, rounded chambers, each 5–7 mm wide; seeds 1–3 per chamber.

Hot, exposed rocky slopes and ridges, usually localized, in many ranges in the western part of Cabeza Prieta and in the Tinajas Altas Mountains, extending to the top of at least the Tule Mountains. *Thamnosma montana* has been in the Tinajas Altas Mountains for more than 37,000 years.

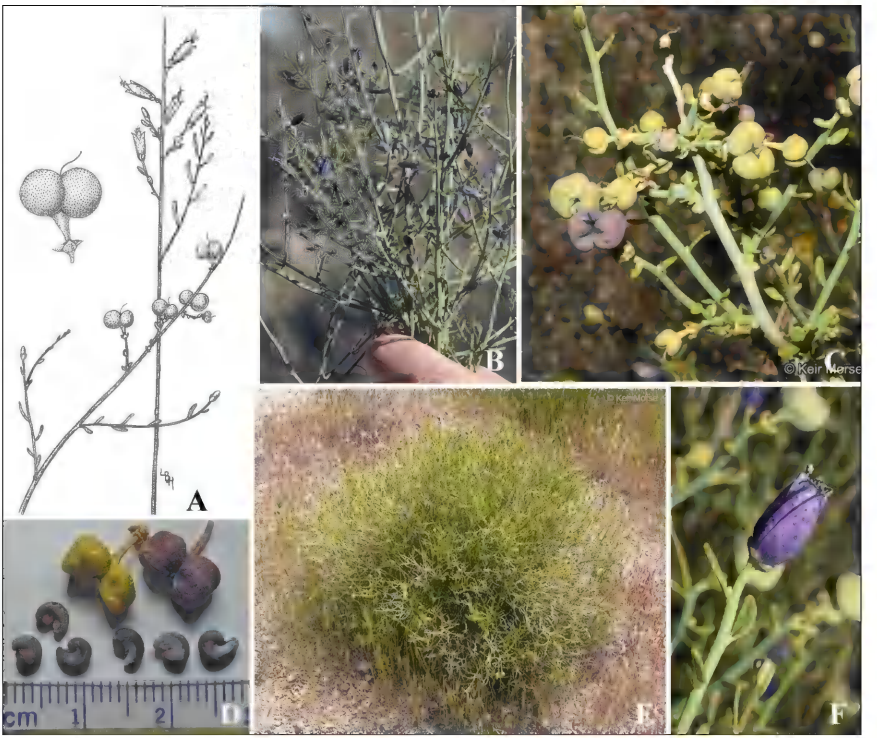

Figure 41. *Thamnosma montana*. (A) By Lucreatia Breazeale Hamilton. (B) First Water, Superstition Mts, Maricopa Co., 10 Feb 2012, photo by Karen Wellner (SEINet). (C & F) Anza Borrego State Park, San Diego Co., CA, 27 Mar 2011, photo by Keir Morse (CalPhotos). (D) The Mohave Cross, Veterans of Foreign Wars Memorial, Cima Rd, Mohave National Preserve, San Bernardino Co., CA, 5 Jun 2013, photo by Jean Pawek (CalPhotos). (E) Hole in the Wall, Mojave National Preserve, San Bernardino Co., 13 Apr 2005, photo by Keir Morse (CalPhotos).

Dry regions in Arizona, southeastern California, southern Nevada, southwestern Utah, Baja California, and extreme northwestern Sonora.

CP: Tule Tank, 25 Nov 1934, *Goodding 211*. E side of Sierra Pinta, *Monson 29 Mar 1957* (CAB). 3 mi W of Tule Well on Camino del Diablo, 18 Apr 1976, *Engard 914* (DES). A-1 Basin, Cabeza Prieta Mt, 11 Mar 1984, *Hodgson 2751* (DES). Tule Mts: NW side, 2 Feb 1992, *Felger 92-62*; top of mountain, 17 Feb 2002, *Rutman & Tibbitts* (observation). Eagle Tank, Heart Tank, 13 & 14 Jun 1992, *Felger*, observations.

TA: Tinajas Altas Mts, 5 Mar 1927, *Harrison & Belden 3612*. SE base of Tinajas Altas Mts, 18 Mar 1998, *Felger 98-103*. †Tinajas Altas, twigs, fruits, 5080 to 15,050 (4 samples) & >37,000 ybp.

SALICACEAE – Willow Family

The two genera in the flora area: Trees and shrubs with soft wood. Leaves winter deciduous, alternate, petioled, and with stipules (often soon deciduous). Male and female flowers on different plants. Flowers in catkins and presumably wind-pollinated, although visited by bees. Calyx vestigial; petals none. Fruit a small capsule. Seeds minute, each with a tuft of long, silky hairs adapted for wind dispersal.

Traditionally this family included only 2 genera, *Populus* and *Salix*. In the APG III system, there are 55 genera with 1010 species including the former Flacourtiaceae.

1. Leaf blades more or less deltoid, about as long as wide; catkins drooping..... **Populus**
1. Leaf blades linear to lanceolate, more than twice as long as wide; catkins erect..... **Salix**

Populus – Cottonwood; *álamo*

Trees and shrubs, northern Hemisphere; 40 species.

***Populus fremontii** S. Watson subsp. **fremontii**

[*P. deltoides* Bartram ex Marshall var. *fremontii* (S. Watson) Cronquist]

Frémont cottonwood; *álamo*; 'auppa. Figure 42.

Softwood trees to 13+ m tall with a broad crown, the leaves winter deciduous. Flowers greenish yellow, in February; fruits ripe late March and early April.

Mearns (1892–1893) wrote, "It is exclusively planted along acequias here [Sonoyta and Quitobaquito], and said to be the cottonwood of the Gila River near Gila Bend." Bryan (1925: 427) reported that, "the pond [at Quitobaquito], which with its fringing cottonwoods makes a refreshing green spot in desert." During the 1990s five cottonwood trees grew at the margin of the pond at Quitobaquito, occasionally producing root sprouts. These trees, all female, were probably planted from cuttings, the nearest source being the nearby Río Sonoyta where the trees were common. In 2016, of the five trees, all but three were dead.

Cottonwoods were often planted at ranches and homesteads — if there was sufficient water to sustain them. According to a letter in the Organ Pipe archives, there were one or more cottonwood trees in Alamo Canyon, but we have found no specimens and no photos. Andrew "Nic" Nichol collected specimens at "Tres Alamos Canyon" in the Ajo Mountains, the name he used for his Alamo Canyon collections of 24 February 1939. "Tres Alamos" refers to the three main branches of the canyon, rather than three cottonwoods. The Gray family, who ranched in the area from 1919 to 1976, called the houses, well, and corrals "The Alamo".

Arizona, California, and Utah to Baja California and northern Sonora. Another subspecies occurs in New Mexico and Texas to the Valley of Mexico.

OP: Quitobaquito: Large tree, 5 Mar 1940, *Peebles 14563*; *Benson 5 Mar 1940*; Edge of pond, 25 Mar 1944, *Clark 11509* (ORPI). Small grove of large trees (one root sprout), these trees all pistillate and probably a single clone, 10 Nov1987, *Felger 87-303*; 19 Jun 1989, *Felger 89-252*.

CP: Simmons (1966) reported a cottonwood tree at Lower Well (the tree was planted and has perished).

Figure 42. *Populus fremontii* subsp. *fremontii*. (A) By Lucretia Breazeale Hamilton. (B) N side of Quitobaquito Pond, 27 Jun 2006.

Salix – Willow; *sauz*

Trees and shrubs (dwarfed at high elevations and in the arctic), worldwide; 450 species.

Salix gooddingii C.R. Ball

[*S. nigra* Marshall var. *vallicola* Dudley]

Goodding willow; *sauz*; ce'ul. Figure 43.

Large shrubs to thick-trunked trees to 8+ m tall, with soft wood. Young herbage hairy, soon glabrate. Leaves winter deciduous, uniformly green on both surfaces, short petioled, narrowly lanceolate, 5.5–11 cm × 8–17 mm. Male flowers with 4–9 stamens. Peak flowering in February and March.

Trees at the Quitobaquito pond and shrubs in canyon bottoms in Alamo Canyon and Bull Pasture in the Ajo Mountains.

Southwestern USA and northwestern Mexico including both Baja California states, Sonora, and Sinaloa.

Cocopah "bows were made from willow, and being less elastic and more liable to break when dry, old ones were seldom seen. Those used for hunting deer were from six to eight feet in length" (Chittenden 1901: 203–204). Small hunting bows for birds and smaller game were also made from willow (MacDougal 1906). For the Hia-Ced O'odham, Lumholtz (1912: 331–332) reports, "To make bows, these Indians travelled as far as the Colorado River to get willow as material."

OP: Quitobaquito: Near edge of pond, small tree, 5 Mar 1940, *Peebles 14562*; Edge of pond, 25 Mar 1944, *Clark 11508* (ORPI, UNM). Spring Canyon [in Bull Pasture], *Bean 19 Feb 1950* (ORPI). N fork of Alamo Canyon, *Fouts 11 Jul 1949* (ORPI). N fork of Alamo Canyon, *Rutman 24 May 1998* (ORPI).

Figure 43. *Salix gooddingii*. Quitobaquito: (A) 11 Sep 2008; (B) 18 Jul 2013; (C) branch with staminate catkins, 25 Feb 2015.

SANTALACEAE – Sandalwood Family (includes Viscaceae)

In collaboration with Kelsey Marie Yule, Ecology and Evolutionary Biology, University of Arizona.

Perennial herbs to trees; includes many hemiparasites. Worldwide, 44 genera, 990 species.

Phoradendron – Mistletoe

Epiphytic parasites, on dicot and conifer trees and shrubs (those in the flora area). Stems photosynthetic, jointed. Male and female flowers on different plants. Flowers small, embedded in a jointed spike, and insect-pollinated. Fruit a globose, sessile berry with mucilaginous pulp. Seeds sticky at one end, germinating on branches of the host trees or shrubs where birds have roosted. Three species are recorded from the flora, two of them only from Ice Age packrat middens. Americas; 235 species.

Phoradendron californicum Nuttall

Desert mistletoe; *toji*; ha:kvad. Figure 44.

Branches arching to drooping, often forming many-branched masses festooning desert trees and shrubs. Stems terete. Leaves scale-like, 1–2.5 mm long. Flowers small, green or yellow; male flowers highly fragrant and attracting great numbers of honeybees and other insects (e.g., Halictidae, Syrphidae, Tephritidae). Flowering and fruiting at various seasons, with massive flowering often December to February, the fruits ripening in late winter to early spring. Berries globose, 4.5–5.5 mm wide, the pulp viscid and translucent whitish, 1-seeded; eaten in quantity by phainopeplas. Seeds 4 mm long.

Parasitic on woody legumes, *Coursetia glandulosa, Olneya tesota*, *Parkinsonia* spp., *Prosopis* spp., *Senegalia greggii*, *Vachellia constricta*, and other plants such as *Condalia*, and common where the hosts occur; occasionally on *Larrea* and rarely on *Asclepias albicans*. Widespread across the flora area for more than 8200 years.

Southeastern California to southwestern Utah, Arizona, and southwestern New Mexico and southward to the Cape Region of Baja California Sur, Sonora, northwestern Sinaloa, and southwestern Chihuahua.

Monson (1943) reported that in Organ Pipe the rancher [Henry Gray] "has already lost four cows from starvation. . . He has even chopped a considerable amount of mistletoe from palo verdes and mesquite in an effort to give his cattle more feed." Mexican ranchers, however, say that if mistletoe is fed to cattle they will abort their fetuses. *Phoradendron* is reported as toxic to cattle and other animals but reports are few (e.g., Burrows & Tyrl 2013). Tim Tibbitts was monitoring Sonoran pronghorn in the Valley of the Ajo on 13 May 2013 and watched them eat *Phoradendron californicum* for hours as well as *Olneya* and *Parkinsonia microphylla* flowers.

Figure 44. *Phoradendron californicum*. (A) By Lucretia Breazeale Hamilton. (B) Aguajita Wash near international boundary, 15 Mar 2015. (C) Alamo Canyon, 26 Feb 2014. (D) Near Montezuma Head, 24 Mar 2008. (E) Victoria Mine, 7 Feb 2014. (F) Phainopepla with expelled mistletoe seeds, middle fork of Alamo Canyon, 24 Mar 2014. (G) Estes Canyon, 2 Mar 2008.

The fleshy fruits were eaten fresh or more often cooked; it is often plentiful and easily harvested (Castetter & Bell 1951; Castetter & Underhill 1935; Rea 1997). The Seris selectively harvested the fruits from mistletoe growing on desert legume trees (Felger & Moser 1985). However, there are many reports that mistletoe berries are toxic (e.g., Kingsbury 1964).

Phoradendron californicum maintains a high transpiration rate to gain water, mineral nutrition, and carbon from the host xylem tissue (Schulze & Ehrleringer 1984). Infestations are only correlated with host mortality under severe drought conditions (Spurrier & Smith 2007). Genetically differentiated races are known to infect *Prosopis* and *Senegalia.* Fruiting phenology of *Phoradendron californicum* does not differ by host species, but flowering phenology is delayed for parasites of *Prosopis* relative to those of other host species (Yule et al. 2016).

Phoradendron californicum is engaged in a specialized mutualistic interaction with the phainopepla (*Phainopepla nitens*). While many birds (e.g., western bluebirds, mockingbirds) consume the berries, the phainopepla is the primary disperser of *Phoradendron californicum*, effectively dispersing an order of magnitude more seeds per plant than the next most common disperser (Cowles 1936; Larson 1996). Phainopeplas have a small gizzard relative to their digestive tract, adapted to remove the exocarps of mistletoe berries for their dispersal in packets of 8–16 intact mistletoe seeds (Walsberg 1975). Phainopeplas defend breeding territories rich in mistletoe berries throughout the period of *Phoradendron californicum* fruiting, leading to a highly aggregated mistletoe distribution (Aukema 2004).

OP: Quitobaquito, 30 Jan 1894, *Mearns 2742* (US). Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, 14 Mar 1941, *Benson 10673*. Vicinity of Senita Basin, *P. californicum* on *Vachellia constricta* and occasionally on *Coursetia glandulosa*, *Yule 7 May 2016*, observation. †Alamo Canyon, twigs, seeds, 1150 & 8130 ybp. †Puerto Blanco Mts, twigs with scale leaves, 1910 to 7970 ybp (5 samples).

CP: Papago Well, 31 Jan 1992, *Felger 92-9*. Tule Well, 14 Apr 1992, *Harlan 285* (CAB).

TA: Coyote Water, on *Prosopis glandulosa*, 25 Oct 2004, *Felger 04-59*. *Felger*, observations: Camino del Diablo near Coyote Wash, on *Asclepias albicans*, 29 Dec 2001; Tinajas Altas, on *Olneya*, 19 Mar 1998. †Butler Mts, fruits, 740 to 8160 ybp (3 samples)

††**Phoradendron juniperinum** Engelmann Juniper mistletoe

This mistletoe is a juniper parasite with leaves reduced to scales. It is documented for the Ajo Mountains between 9600 and 22,000 years ago. It apparently grew on two or more different juniper species: *Juniperus californicus* and *J.* aff. *arizonica/coahuilensis* were the only junipers present in Alamo Canyon 9600 years ago, and *J.* cf. *osteosperma* and *J. scopulorum* were the only ones at Montezuma's Head 20,500 to 29,900 years ago. The nearest present-day populations of this mistletoe are in the Santa Rita and Santa Catalina mountains near Tucson.

Western USA and northern Mexico.

OP: †Alamo Canyon, twigs, fruits, 9570 ybp. Montezuma's Head, twigs, fruits, 20,490 & 21,840 ybp.

††**Phoradendron serotinum** (Rafinesque) M.C. Johnston

This broad-leaved mistletoe was in the Ajo Mountains 13,500 to 32,000 years ago. These fossils are from small-leaved forms. Oaks are the most likely host plant, and *Quercus turbinella* is the only oak known from the Ajo Mountains. There are, however, other potential hosts.

This mistletoe species is wide ranging in western USA and northern Mexico. Two subspecies may have been in the Ajo Mountains: subsp. *macrophyllum* (Engelmann) Kuijt, which grows on a wide range of hosts other than oaks, including canyon hackberry (*Celtis reticulata*), Arizona ash (*Fraxinus velutina*), soapberry (*Sapindus drummondii*), and cottonwoods (e.g., *Populus fremontii*). The nearest known populations are in the Baboquivari Mountains. It also grows on cottonwood (*Populus fremontii*) in the lower Colorado River, such as at Yuma. Subspecies *tomentosum* (de Candolle) Kuijt is a common parasite of oaks and today occurs in the Baboquivari Mountains.

OP: †Alamo Canyon, twigs, leaves, 14,500 & 32,000 ybp. Montezuma's Head, twigs, leaves, 13,500 & 21,840 ybp.

SAPINDACEAE – Soapberry Family

Trees, shrubs, or vines, or rarely herbaceous. Leaves almost always alternate, usually compound, seldom entire; stipules usually none. Flowers often unisexual. Fruits dry or fleshy. Worldwide, greatest diversity in Asia and America, tropical and subtropical, few in deserts; 140 genera, 1325 species.

1. Leaves simple; evergreen or sometimes drought deciduous..... **Dodonaea**
1. Leaves pinnately compound; winter deciduous..... **Sapindus**

Dodonaea

Shrubs or small trees. Leaves simple (or pinnate elsewhere). Fruits of capsules. Mostly Australian, several from Madagascar, Java, and Hawaii; 1 in the Americas; 50 species.

Dodonaea viscosa Jacquin var. **angustifolia** (Linnaeus f.) Bentham
Hop bush; *saucillo*, *tarachico*. Figure 45.

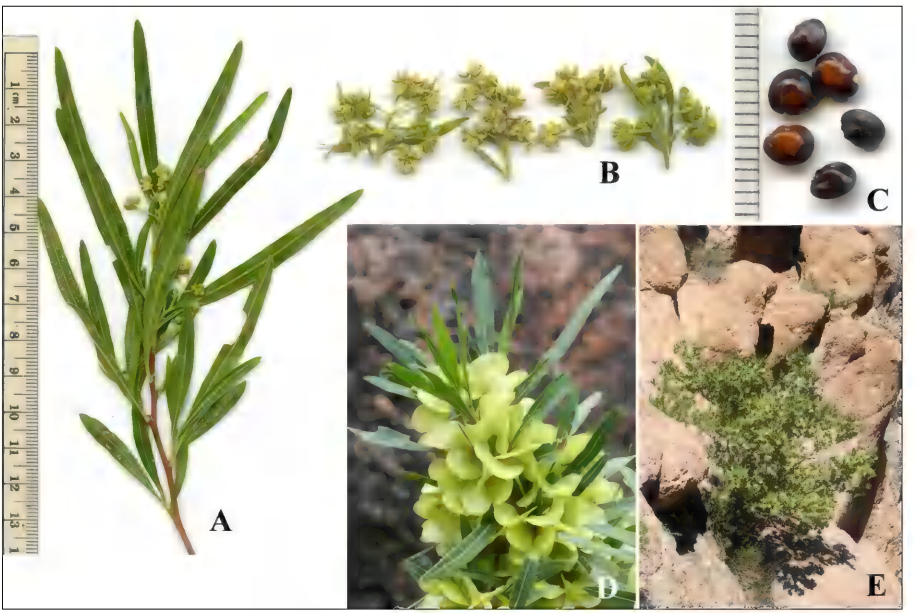

Figure 45. *Dodonaea viscosa* var. *angustifolia*. Alamo Canyon: (A) 3 Sep 2014; (B) Staminate flowers, 10 Sep 2008; (C) 4 Apr 2015; (D & E) 18 Mar 2005.

Leafy shrubs often 1–1.5 (2+) m tall with shredding-peeling bark, the branches mostly erect-ascending. Herbage, especially when young, ovaries, and developing fruits, densely resinous-glutinous. Leaves evergreen or very tardily drought deciduous, 3–9 cm × 3–9 mm, linear to linear-oblanceolate, narrowed at base and essentially sessile, the midrib prominent, the margins entire;

stipules none. Male and female flowers on different plants and occasionally with some bisexual flowers. Flowers in small clusters among the leaves, pedicelled, and yellow-green; sepals 2 mm long, often 4 in number; petals none. Male flowers with mostly 8–10 stamens. Fruits of 3-winged, papery capsules 1–2 cm wide. Seeds 3–3.5 mm wide, dull blackish.

Mostly on rocky slopes, especially at higher elevations in the Ajo Mountains, and also in the Puerto Blanco Mountains.

In the Sonoran Desert Region often in the ecotone between desert and oak woodland. This species in southeastern California to west Texas and Mexico, as well as worldwide in tropics and subtropics. There is much variation in leaf size. The narrow-leaved plants from Arizona and northwestern Mexico have been called var. *angustifolia*, which is sometimes considered a distinct species. However, the broader-leaved var. *viscosa* sometimes occurs within the same region.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. Alamo Canyon, 13 Dec 1939, *Harbison 26240*. Dripping Springs, 16 Apr 1952, *Parker 7962*. Arch Canyon, 28 Mar 1965, *Lockwood 159*.

Sapindus

Trees and shrubs, New World, Asia, and Oceania; 13 species.

Sapindus drummondii Hooker & Arnott
[*S. saponaria* Linnaeus var. *drummondii* (Hooker & Arnott) L.D. Benson]
Soapberry; *jaboncillo, amolillo*. Figure 46.

Mostly slender-stemmed, spindly shrubs, but sometimes trees, 2–5 m tall; often propagating by root sprouts. Herbage with soft, white to golden colored curved hairs. Leaves winter deciduous, often 15–30 cm long, pinnately compound with 10–19 leaflets; leaflets lanceolate, tapering to a slender point, moderately asymmetric with entire margins, the larger leaflets 4–8.5 × 1–2 cm; leafstalks, especially the larger ones, narrowly winged. Male and female flowers on separate plants and also with some bisexual flowers, in dense, terminal panicles. Flowers cream-white, 4–5 mm wide, often densely pubescent especially at the petal bases. Sepals and petals each 5, the petals more or less elliptic to broadly obovate, 2.5–2.8 × 1–2 mm. Male flowers with 8–10 stamens. Fruits mostly 1-lobed by abortion of the other 2 lobes; each lobe 12–15 mm wide, amber colored, drupe-like, globose, and 1-seeded.

Organ Pipe in Alamo and Estes canyons, and abundant at Cherioni Wash near the well. Canyon bottoms and along some larger xeroriparian washes.

Border region of southwestern USA and northern Mexico.

Common names found in the literature include *amolillo*, cherioni, cherrion, Chinaberry, Drummond soapberry, Indian soap plant, *jaboncillo*, Mexican soapberry, soapberry, and western soapberry. Bryan (1925: 182) reported, "The site of Cherioni Well was chosen because of the presence of a large cherioni tree. In this instance the tree indicated water at shallow depth, but not in sufficient quantity to be valuable." Cherioni trees remain abundant in the area. Cherioni is also a term for a soil type or series—a very shallow soil over a hardpan.

As indicated by the common names, the fruits were widely used for soap (Uphof 1968), although such use is not documented for the flora area (Felger 2007). The Tohono O'odham made arrow foreshafts from the straight stems, although creosotebush (*Larrea*) was preferred (Castetter & Underhill 1935).

OP: Alamo Canyon, 2600 ft, 13 Jun 1978, *Bowers 1340.* Cherioni Well, *Jackson 26 May 1966* (ORPI).

Figure 46. *Sapindus drummondii*. (A) By Lucretia Breazeale Hamilton. (B) Staminate plant, La Cueva, Organ Mountains, Doña Ana Co., NM, 7 Sep 2006, photo by Patrick Alexander (SEINet). (C) Alamo Canyon, 7 Sep 2013.

SCROPHULARIACEAE, see OROBANCHACEAE, PHRYMACEAE, and PLANTAGINACEAE (Felger & Rutman 2016, part 17).

SIMAROUBACEAE – Quassia Family

Trees and shrubs. Leaves alternate, simple or odd-pinnate, without stipules, or essentially leafless. Warmer regions of the world, few in deserts; 20 genera, 120 species.

Castela

Mostly leafy, drought-deciduous shrubs. Semiarid subtropical to arid regions of the Americas; 15 species.

Castela emoryi (A. Gray) Moran & Felger
[*Holacantha emory*i A. Gray]
Crucifixion thorn; *corona de cristo*. Figure 47.

Shrubs and small trees, essentially leafless, mostly 2–4+ m tall with well-developed trunks, the wood very hard and twisted, the twigs rigid, thick, thorn-tipped, and moderately to densely pubescent with short white hairs, glabrous with age. Seedlings and young plants with slender,

flexible and moderately leafy stems, the nodes with short, sharp spines and alternate and quickly drought-deciduous leaves to 1 cm long. Mature plants essentially leafless, the new growth with few, quickly deciduous scale leaves. Flowers crowded in dense, many-branched panicles 1.5–15 cm long, the flowering branches pubescent and pinkish. Flowers 8–9 mm wide, radial, the petals often 7, cupped, mostly cream-yellow to greenish or rose-pink; stigmas chartreuse, the ovaries green, becoming red as the petals fall; flowers often tended by black ants. Flowering April to early summer. Fruits in dense, short clusters, persisting for several years or more in the outer branches, with woody carpels in a star-shaped pattern.

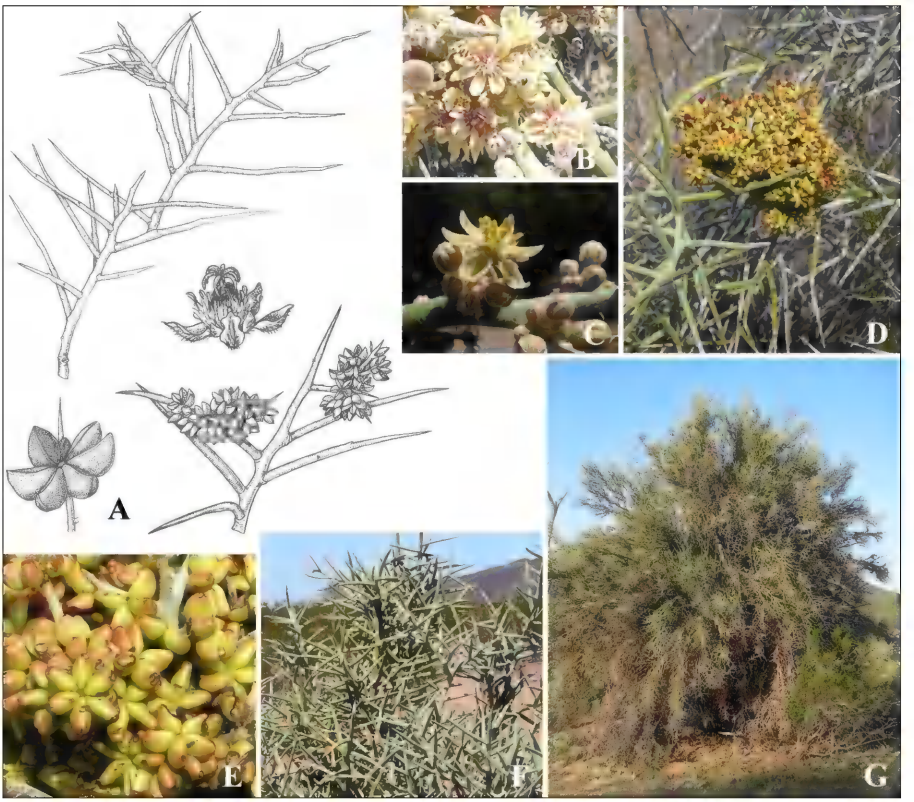

Figure 47. *Castela emoryi*. (A) By Lucretia Breazeale Hamilton. Just W of 17th Ave and Pecos Road S of South Mountain Park, Phoenix, Maricopa Co., photos by Leslie R. Landrum (SEINet): (B) 2 Jul 2004; (C) 13 Apr 2010. Cuerda de Leña, N boundary of Organ Pipe: (D & E) 22 Aug 2012; (G) 17 Sep 2013. (F) Growler Valley, 8 Oct 2006.

Widely scattered in mostly small, localized populations or sometimes extensive in Cabeza Prieta; creosotebush flats and often on nearly barren sandy soils of valley plains.

Southwestern Arizona, southeastern California, northern Baja California, and scarce in northwestern Sonora. Jim Malusa found the world record *Castela emoryi*, 25 feet tall with a crown

23 feet wide, in the Cuerda de Leña wash near the northern border of Organ Pipe (Arizona Registry of Big Trees 2005).

OP: Bates Well, *Harbison 20 Nov 1939* (SD). 1.5 mi E of junction at Bates Well, in a narrow canyon, 18 Mar 1945, *Gould 3012*. Cuerda de Leña Wash near N boundary of Monument, 24 Jul 1978, *Bowers 1382* (ORPI). Armenta Ranch, *Rutman 16 Aug 2001* (ORPI).

CP: Adobe Windmill, a colony of about 2 dozen plants,12 Jun 1992, *Felger 92-545*. E Pinta Sands, 16 Jun 1992, *Felger 92-629*. Observations: Southward and to 5 km E of Redtail Tank, 12 Jun 1992, *Felger*; Chico Suni Temporal, 25 Feb 1993, *Felger*.

SIMMONDSIACEAE – Jojoba Family

This family has a single species.

Simmondsia chinensis (Link) C.K. Schneider
Jojoba; hohovai. Figure 48.

Woody shrubs, evergreen or very tardily partially to rarely fully deciduous during extended drought. Leaves opposite, 2–5 cm long, often held upright, somewhat leathery and dull green to grayish, elliptic, lanceolate or oblanceolate, entire, sessile or short-petioled; stipules none. Male and female flowers on separate plants; flowering in January. Male flowers many in short-stalked clusters, the sepals 4–6, yellow-green, 2–5 mm long, petals none, stamens 8–12+. Female flowers single in leaf axils, green, the sepals 5, 8–12 mm long in flower, enlarging to 20 mm long in fruit; ovary with three ovules, but usually only one seed develops; seeds 1.5–2 cm long.

Northern and eastern part of Organ Pipe including the Ajo, Diablo, and Puerto Blanco mountains, and Copper Canyon just east of the Cabeza Prieta boundary (Simmons 1966); especially common at higher elevations in the Ajo Mountains. Jojoba is relished by bighorn sheep and deer (Simmons 1966). It was in the Ajo Mountains 1200 years ago.

Southern Arizona, southwestern New Mexico, southern California, both states of Baja California, and northwestern Sonora to the Guaymas region.

The seeds are the largest of any plant in the flora area and one of the largest of any Sonoran Desert plant. The thick, fleshy cotyledons contain simmondsin, a cyanogenic glucoside, and a high percentage of the unique liquid wax, which is the basis of the jojoba industry. The seeds have been used for food (Castetter & Underhill 1935; Meigs 1939) but are nutritionally marginal or not digestible. The Seris regarded them as an emergency food (Felger & Moser 1985). The Cahuillas made a coffee substitute from the ground seeds (Bean & Saubel 1972). Sonoran Desert people valued the seed oil (actually a liquid wax) for shampoo and hair care (Felger and Moser 1985). There is a long history of medicinal use of the seeds to treat many ailments, including colds, eye problems, and sores, and for women at childbirth (del Barco 1980; Castetter & Underhill 1935; Felger and Moser 1985). Kino reported that jojoba was esteemed for its medicinal properties, and in the late seventeenth century it was in demand in Mexico City and even in Spain (Burrus 1954, 1971).
OP: Alamo Canyon, *Nichol 4 May 1939* (ORPI). Dripping Springs, 16 Apr 1952, *Parker 7954*. Estes Canyon, *Warren 9 May 1975*. Arch Canyon, 11 Mar 1983, *Daniel 2584* (ASU). Diablo Canyon, Diablo Mts, 3000 ft, *Tibbitts 6 Mar 2003*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger* (observation). †Alamo Canyon, leaf fragments, fruits, 1150 ybp.

Figure 48. *Simmondsia chinensis*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon, 30 Jan 2014. Estes Canyon: (C) Pistillate flowers, 30 Jan 2014; (D) Staminate flowers, 3 Apr 2010; (E) Staminate plant, 2 Mar 2008. (F & G) Ajo, 8 Jul 2015.

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Semple, J.C. , R. Lopez Laphitz, H. Rahman, and Yunfei Ma. 2016. On *Solidago durangensis* (Asteraceae: Astereae): A multivariate study with specimens of subsect. *Junceae*, subsect. *Maritimae*, and subsect. *Triplinerviae*. Phytoneuron 2016-48: 1–19. Published 8 July 2016. ISSN 2153 733X

ON *SOLIDAGO DURANGENSIS* (ASTERACEAE: ASTEREAE): A MULTIVARIATE STUDY WITH SPECIMENS OF SUBSECT. *JUNCEAE*, SUBSECT. *MARITIMAE*, AND SUBSECT. *TRIPLINERVIAE*

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ABSTRACT

Nesom (1991) described *Solidago durangensis* based on three collections from Durango, Mexico. The protologue was not illustrated; detailed illustrations of the species are presented here. The species has been included at different times in three different subsections of the genus. Multivariate morphometric analyses were performed on specimens of *S. argentinensis* and *S. missouriensis* of *Solidago* subsect. *Junceae*, *S. paniculata* of subsect. *Maritimae*, and *S. chilensis*, *S. juliae*, and *S. pringlei* of subsect. *Triplinerviae*. Two specimens of *S. durangensis* were scored and were not assigned to an a priori group but were included in the a posteriori classificatory discriminant analyses. Three multivariate analyses were performed. In the two 6-species analyses, the two specimens of *S. durangensis* were placed a posteriori into *S. chilensis* and *S. juliae,* respectively, and into *S. pringlei* and *S. juliae*, respectively. In the third analysis involving only the three species of subsect. *Triplinerviae*, the specimens of *S. durangensis* were placed a posteriori into *S. pringlei* and *S. juliae*. An additional specimen treated previously as either *S. pringlei* or *S. missouriensis* was also included in the analyses and was placed into *S. pringlei* in both 6-species group analyses and into *S. chilensis* in the third analysis. The results provide strong evidence that *S. durangensis* is most similar to species in subsect. *Triplinerviae* and on distinctive morphological features should be recognized as a very rare endemic species.

Nesom (1991) described *Solidago durangensis* Nesom (Figs. 1-4) but did not illustrate the new species. He stated that "the closest relative of the new species is hypothesized to be *S. paniculata* DC.". *Solidago paniculata* (Figs 5-6) is the inland central Mexican member of *Solidago* subsect. *Maritimae* (Torr. & A. Gray) Nesom that includes the bog and marsh goldenrods: e.g., *S. mexicana* L., *S. sempervirens* L., *S. uliginosa* Nutt., and *S. virgata* Michx. (Semple 2016, frequently updated). Nesom (1993) included *S. durangensis* in subsect. *Triplinerviae* (Torr. & A. Gray) Nesom. When the first author examined limited herbarium material of *S. durangensis*, several traits were most striking. First the rather corymbiform inflorescence arrays were atypical in both subsect. *Maritimae* and subsect. *Triplinerviae*. Second, the dense, short hairy indument on the stems does not occur in subsect. *Maritimae* but is common in the *Tortifolia* group of subsect. *Triplinerviae*. The lack of lower stem material made it impossible to determine if the lower stem leaf petioles sheathed the stem as they do in all species of subsect. *Maritimae*. Semple (2016, frequently updated; versions in 2013-2016) placed *S. durangensis* into subsect. *Junceae* (Rydb.) Nesom in 2013 based on the fact that "*Palmer 217* (F, MO) have fascicles of small leaves in the axes of some upper stem leaves" and that the "branching pattern of the inflorescence is more like *S. juncea* and *S. missouriensis* than members of *S.* subsect. *Triplinerviae*." Densely hairy stems are not known in subsect. *Junceae*, but *S. argentinensis* Semple & Lopez Laphitz can be distally rather hairy, especially for the subsection. It was noted that additional research was needed on this rare species. Semple and Cook (2006) described the defining traits of each subsection. Regardless of its subsectional affinities, Nesom (1991) was correct in treating *S. durangensis* as a distinct species.

Figure 1. Isotype of *Solidago durangensis; E. Palmer 363* (GH).

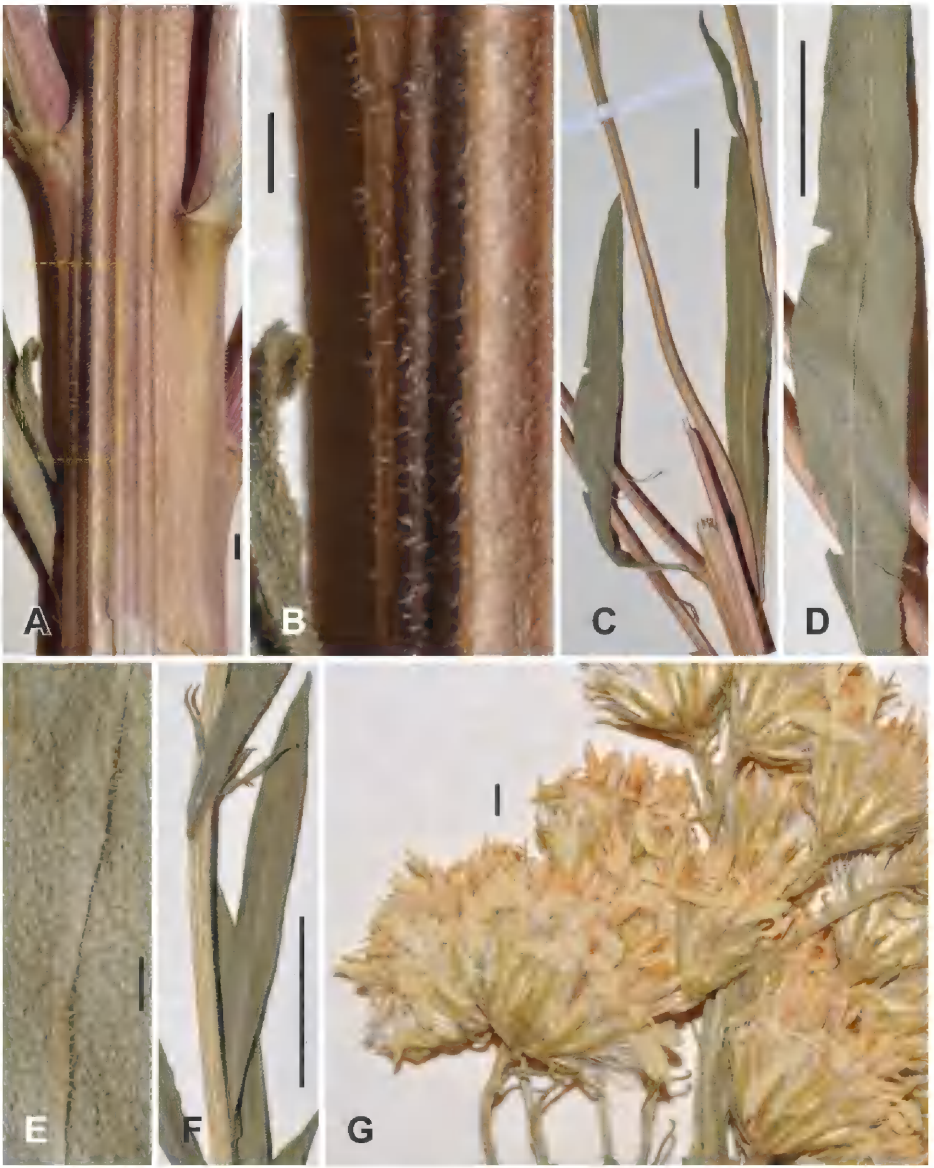

Figure 2. Details of isotype of *Solidago durangensis*, *E. Palmer 363* (GH): stem, leaves and heads. **A-B.** Mid stem and enlargement of area in dashed outline. **C.** Mid stem leaves. **D.** Mid stem leaf, abaxial surface, weakly trinervate. **E.** Mid vein area of leaf in D. **F.** Upper branch and leaves. **G.** Heads. Scale bar = 1 mm in A, B, E, and G; = 1cm in C, D, and F.

Figure 3. *Solidago durangensis*; *E. Palmer 217* (F) from Durango, Mexico.

Figure 4. *Solidago durangensis*; *E. Palmer 217* (MO) from Durango, Mexico.

Figure 5. *Solidago paniculata*; *Daniels 611* (F) from El Rosario, Dist. Federales, Mexico.

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MEXICO
Multivariate Studies in Solidago
Solidago subsect. Meridionales
K. Kompas & J.C. Semple Specimen No.
WAT 2013 University of Waterloo
Solidago paniculata
Det. John C. Semple 2011
WAT University of Waterloo
HERBARIO NACIONAL MEXICO (MEXU)
INSTITUTO DE BIOLOGIA, U.N.A.M.
DC
José Luis Villaseñor 2013
904992
Instituto de Ecología
Centro Regional del Bajío
PLANTAS MEXICANAS
Solidago paniculata DC.
Fam Compositae
Loc Agua Verde, municipio de Santa Clara del Cobre
Estado MICHOACAN Fecha 7.XI.1989
Hab lugares resecos, en la orilla del Lago de Zirahuén
Alt 2050 m
Col E. Pérez Calix No 845
Observ. planta herbácea de 2 m de alto; flores amarillas
Det E. Pérez Calix

Figure 6. *Solidago paniculata*; *Pérez Calix 845* (MEXU) from Agua Verde, Michoacán, Mexico.

In order to explore morphological similarities and differences among *Solidago durangensis* and possible related species, multivariate morphometric comparisons were performed on *S. argentinensis* and *S. missouriensis* Nutt. of subsect. *Junceae*, *S. paniculata* DC. of subsect. *Maritimae*, and *S. chilensis* Meyen, *S. juliae* Nesom, and *S. pringlei* Fern. of subsect. *Triplinerviae*. The results are presented below.

NOMENCLATURE

Solidago durangensis Nesom, Phytologia 70: 58. 1991. **TYPE**: **MEXICO**. **Durango**. City of Durango and vicinity, Apr-Nov 1896, *E. Palmer 363* (holotype: US, digital image!; isotypes: GH! (Figs 1-2), US, digital image!).

Additional collections examined: **MEXICO**. **Durango**. Durango and vicinity, Apr-Nov 1896, *E. Palmer 217* (F, Fig. 3; MO, Fig. 4).

MATERIALS AND METHODS

In total, 133 specimens from BRIT, F, GH, LL, LP, MEXU, MO, TEX, and WAT in MT (Thiers, continuously updated) were included in the analysis. Data on *Solidago chilensis* (80 specimens), *S. juliae* (11 specimens), and *S. missouriensis* (16 specimens) were measured by the second author for her M.Sc. thesis (Lopez Laphitz 2009) and for Lopez et al. (2011) and used in Lopez Laphitz and Semple (2015) and Semple and Lopez (2016). Specimens of *S. pringlei* (11 specimens) were scored by the first author and first used in Semple and Lopez (2016). New data on *S. durangensis* (two specimens), *S. paniculata* (10 specimens) were scored for this study by the third and fourth authors, and one *S. pringlei* specimen thought to be *S.* "aff. *missouriensis*" was scored for this study by the first author; this latter specimen was the smaller shoot on *Nesom & Morgan 5302* (TEX; Fig. 7) noted as being annotated as *S. missouriensis* (Semple & Lopez Laphitz 2016). For each specimen, 13 vegetative and 16 floral traits were scored when possible: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait.

Traits used to define a prio*ri* groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics, lower stem pubescence density, and leaf pubescence density were used to define a priori groups along with geographic location. Lower stem leaf traits were not included in the analyses because these were often not present on specimens.

All analyses were performed using SYSTAT v.10 (SPSS 2000). A pair-wise Pearson correlation matrix was created to determine which characters were highly correlated. One trait of each pair that had a $> |0.7|$ correlation value was excluded from the analysis to avoid possible pleiotropic effects of a single gene and to make the tests of null hypotheses more stringent. Stepwise discriminant analysis (STEPDISC) was used to select traits that best separated groups based on the Mahalanobis distances between a priori group centroids in N-dimensional hyperspace. Classificatory Discriminant Analysis was run on N-1 traits selected by the STEPDISC analysis, if more than N-1 traits were selected, where N = lowest sample size of the a priori groups; in this study N=10 and 7 (*Solidago paniculata*; not all traits could be scored on all specimens resulting in few collections being used in the second analysis). A COMPLETE analysis was then run using only five traits. Geisser probabilities of assignment to each a priori group were generated a posteriori for each specimen based on the Mahalanobis distances from the specimen location plotted in N-dimensional hyperspace to each a priori group centroid. Linear and Jackknifed analyses were run in each classificatory analysis to test the strength of group separation in terms of the numbers of discriminating traits. Results are presented in the form of F-value matrices based on Mahalanobis distances between group centroids and tables summarizing the results of the two methods of doing the classificatory discriminant analyses. Conclusions were reached based (1) on the percents of correct placements of specimens a posteriori, (2) on the probabilities of those placements being correct, and (3) on visual reexamination of each specimen via high resolution digital images or the actual

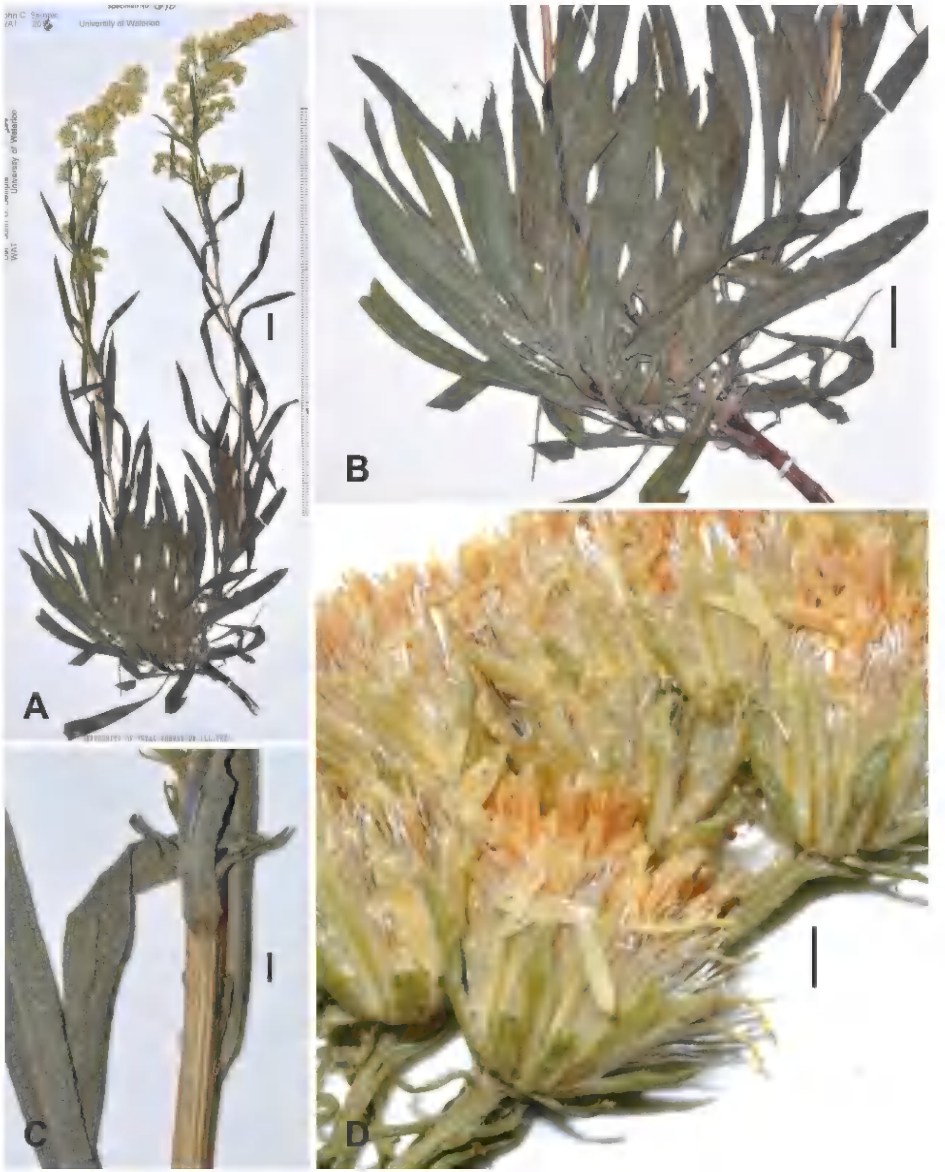

Figure 7. *Solidago "aff. missouriensis" Nesom & Morgan 3502* (TEX) from Nuevo León, Mexico. **A.** Shoot. **B.** Lower or mid stem leaves depending upon how much of the whole shoot is present. **C.** Upper stem and leaves with several small lateral branch leaves in the axes. **D.** Heads. Scale bar = 1 cm in A, B; = 1 mm in C, D. The specimen is more likely an aberrant or damaged shoot of *S. pringlei*.

Table 1. Traits scored for the multivariate analyses of specimens of *Solidago argentinensis*, *S. chilensis*, *S. durangensis*, S. *juliae*, *S. missouriensis*, and *S. pringlei*.

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
LLFLN	Lower leaf length measured from the leaf base to tip(mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end(mm)
LLFSER	Lower leaf dentation-number of serrations of lower leaf
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf dentation-number of serrations of mid leaf
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end(mm)
ULFSER	Upper leaf dentation-number of serrations of upper leaf
CAPL	Length of inflorescence (cm)
CAPW	Width of inflorescence (cm)
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
OPHYLW	Outer phyllary width (mm)
IPHYLN	Inner phyllary length (mm)
IPHYLW	Inner phyllary width (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)

specimens. Lastly, a canonical analysis was performed as a dimension reduction technique to allow visualization of results in 1 to 3 dimensions with the number of dimensions being N-1, where in this case N equals the number of a priori groups in an analysis. While canonical analysis allows for a visual presentation of results, the plots are based on fewer axes than were used in the statistical analyses and thus do not fully show the multi-dimensional nature of the separation of a priori groups.

Three analyses were performed. Two six-species a priori groups analyses was performed including 136 specimens of *Solidago argentinensis* and *S. missouriensis* of subsect. *Junceae*, *S. paniculata* of subsect. *Maritimae*, *S. chilensis*, *S. juliae* and *S. pringlei* of subsect. *Tripinerviae*, plus a posteriori two collections of S. *durangensis* and one collection of *S. "aff. missouriensis."* In the first

analysis, mid stem leaf traits were included, but not upper stem leaf traits. In the second analysis, upper stem leaf traits were included but not mid stem leaf traits. The third analysis was performed including just the 102 specimens of *S. chilensis*, *S. juliae*, and *S. pringlei* plus a posteriori two collections of S. *durangensis* and one collection of S. "*aff. missouriensis*."

RESULTS

Six taxon analysis with mid stem leaf traits

In the COMPLETE discriminant analysis of six species level a priori groups *Solidago argentinensis*, *S. chilensis*, *S. juliae*, *S. missouriensis*, *S. paniculata*, and *S. pringlei*, the following five traits were included from a longer list selected in a preliminary STEPWISE analysis and are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (27.52), disc corolla length (18.71), ray floret lamina length at anthesis (16.51), disc corolla lobe length (9.00), and mid leaf length (5.02). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *S. chilensis* and two species of subsect. *Junceae, S. missouriensis* and *S. argentinensis* (108.783 and 88.486, respectively), and the least separations (F-to separate) were between *S. juliae* and *S. pringlei* (5.967) and between *S. chilensis* and *S. pringlei* (9.146) of subsect. *Triplinerviae* and between S. *argentinensis* and *S. missouriensis* (9.824) of subsect. *Junceae*.

Table 2. Between groups F-matrix for the six a priori group analysis including mid stem leaf traits (df = 5, 130).

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*
chilensis	88.486				
juliae	38.805	22.206			
missouriensis	9.824	108.783	31.507		
paniculata	79.157	28.961	30.267	91.114	
pringlei	35.641	9.146	5.967	28.861	27.034

Wilks' lambda = 0.0277 df = 5 5 134
Approx. F = 34.4700 df = 25 484 prob = 0.0000

In the a posteriori Classificatory Discriminant Analysis of the six species level a priori groups plus the two specimens of *Solidago durangensis* and one specimen of *S. "aff. missouriensis,* the percentage of correct placement to the a priori group ranged from 64-90% (Table 3). The Classification matrix and Jackknife classification matrix are presented in Table 3. Results are presented in decreasing order of percent correct placement. Nine of the 10 specimens of *S. paniculata* were placed a posteriori into the *paniculata* group with 90-100% probability; 1 specimen was placed into the *S. chilensis* group with 70% probability (28% into *S. paniculata*). Fourteen of 16 specimens of *S. missouriensis* (88%) were assigned a posteriori to the *S. missouriensis* group; 9 with 95-100% probability, 2 with 83% and 84% probability; 1 with 65%; and 2 with 52% and 57% probabilities; all other lower probabilities of placement were into the *S. argentinensis* group. Two *S. missouriensis* specimens were placed a posteriori into the *S. argentinensis* group with 69% and 68% probabilities (31% and 32% probabilities to *S. missouriensis*). Seventy of the 80 specimens of *S. chilensis* (88%) were assigned a posteriori to the *S. chilensis* group; 41 with 90-100% probability, 12 with 80-89% probability; 8 with 69-79% probability; and 9 with 45-62% probability. Ten specimens of the *S. chilensis* a priori group were assigned a posteriori to other species; 6 to *S. pringlei* with 59-87% probability; 2 to *S. juliae* with 87% and 98% probabilities; 1 to *S. argentinensis* with 100% probability; and 1 to *S. paniculata* with 55% probability (44% to *S. chilensis*).

Nine of the 11 specimens of *S. juliae* (82%) were assigned a posteriori to the *S. juliae* group; 6 with 95-100% probability; 1 with 74% probability (26% to *S. pringlei*); 1 with 59% probability (36% to *S. chilensis*); and 1 with 51% probability (40% to *S. juliae* and 1% to *S. chilensis*). Two specimens of the *S. juliae* a priori group were assigned a posteriori to *S. pringlei* with 69% and 59% probability (30% and 40% to *S. juliae*). Seven of the 11 *S. pringlei* specimens (64%) were assigned a posteriori to the *S. pringlei* group; 3 with 97-98% probability; 2 with 88% and 81% probabilities; and 2 with 74% and 72% probabilities. Four specimens of the *S. pringlei* a priori group were assigned a posteriori to other species: 2 to *S. chilensis* with 80% and 41% probabilities (20% and 41% *S. pringlei*, respectively); 1 to *S. juliae* with 57% probability (38% to *S. pringlei*); and 1 to *S. paniculata* with 46% probability (27% to *S. chilensis*, 24% to *S. pringlei*)

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of six a priori groups using mid stem leaf traits; a posteriori placements to groups in rows.

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*	*pringlei*	% correct
argentinensis	10	0	0	2	0	0	83
chilensis	1	70	2	0	1	6	88
juliae	0	0	9	0	0	2	82
missouriensis	2	0	0	14	0	0	88
paniculata	0	1	0	0	9	0	90
pringlei	0	2	1	0	1	7	64
Totals	13	73	12	16	11	15	85

Jackknifed classification matrix

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*	*pringlei*	% correct
argentinensis	10	0	0	2	0	0	83
chilensis	1	69	2	0	2	6	86
juliae	0	1	7	0	0	3	64
missouriensis	4	0	0	12	0	0	75
paniculata	0	1	0	0	9	0	90
pringlei	0	2	1	0	1	7	64
Totals	15	73	10	14	12	16	81

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago argentinensis*, *S. chilensis*, *S. juliae*, *S. misssouriensis*, *S. paniculata*, and *S. pringlei*, and the two collections of *S. durangensis* and the one collection of *S.* "aff. *missouriensis*" are presented in Fig. 8. Eigen values on the first three axes were 7.050, 0.983, and 0.827.

Six taxon analysis with upper stem leaf traits

In the STEPWISE discriminant analysis of 120 specimens in six species level a priori groups *Solidago argentinensis*, *S. chilensis*, *S. juliae*, *S. missouriensis*, *S. paniculata*, and *S. pringlei*, the following six traits were selected and are listed in order of decreasing F-to-remove values: disc floret pappus length (28.16), disc corolla length (27.43), ray floret lamina length at anthesis (17.83), disc corolla lobe length (8.56), ray floret lamina width (6.17), and disc floret cypsela body length at anthsis (4.40). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of $p = 0.000$ that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 4. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *S. chilensis* and *S. missouriensis* (102.792) and between *S. missouriensis* and *S. paniculata* (82.248) and the least separation was between *S. juliae* and *S pringlei* (4.532) and between *S. argentinensis* and *S. missouriensis* (14.721).

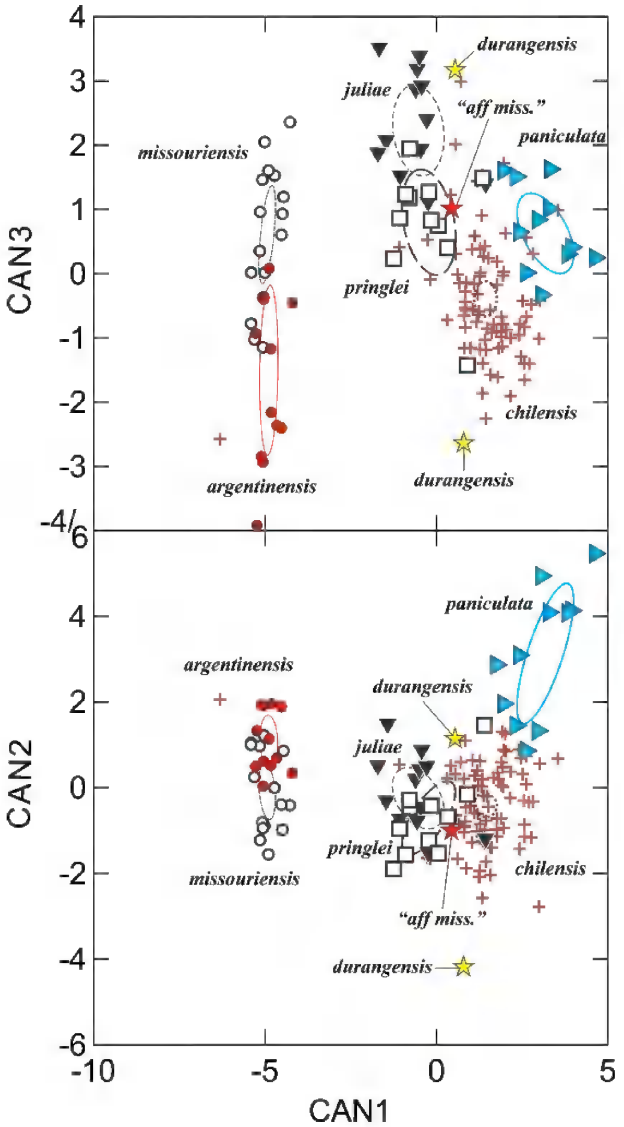

Figure 8. Plots of CAN1 versus CAN3 and CAN1 versus CAN2 of 136 specimens included in the first six a priori groups analysis: *Solidago argentinensis* (red dots) and *S. missouriensis* (circles) of *S.* subsect. *Junceae*, *S. paniculata* of *S.* subsect. *Maritimae*, *S. chilensis* (brown +), *S. juliae* (black triangles) and *S. pringlei* (white squares with black outlines) of *S.* subsect. *Tripinerviae*, and two collections of S. *durangensis* (yellow stars) and one collection of aff. "*missouriensis*" (red star) that is likely an aberrant *S. pringlei*; COMPLETE analysis with mid stem leaves; 95% confidence ellipses are shown for each group.

Table 4. Between groups F-matrix for the six a priori group analysis including upper leaf traits (df = 5, 130).

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*
chilensis	63.847				
juliae	31.199	21.801			
missouriensis	14.721	102.792	28.374		
paniculata	56.987	34.900	31.527	82.248	
pringlei	27.220	12.237	4.532	24.895	33.963

Wilks' lambda = 0.0277 df = 6 5 130
Approx. F = 29.9599 df = 30 502 prob = 0.0000

In the a posteriori Classificatory Discriminant Analysis of the six species level a priori groups plus the two specimens of *Solidago durangensis* and the one specimen of *S.* aff. *missouriensis*, *S. paniculata* was the only a priori group with 100% placement of its specimens a posteriori to their a priori group; a posteriori assignments for other groups ranged from 73-94% to their own group (Table 5). The Classification matrix and Jackknife classification matrix are presented in Table 6. Results are presented in decreasing order of percent correct placement. All seven specimens of *S. paniculata* were assigned a posteriori with 100% probability to the species. Fifteen of 16 specimens of *S. missouriensis* (94%) were placed a posteriori into the *S. missouriensis* group: 12 specimens with 91-100% probability; and 3 with 81%, 73% and 58% probabilities (19%, 27% and 42% to *S. argentinensis*. Eleven of 12 specimens of *S. argentinensis* (91%) were assigned a posteriori to the *S. argentinensis* group *S. missouriensis* with 95% probability (5% to *S. argentinensis*). Ten of the 11 specimens of *S. pringlei* (91%) were assigned a posteriori to the *S. pringlei* group: 3 with 95-99% probability, 4 with 82-88% probability; 1 with 79% probability (21% to S. *chilensis*); and 2 with 64% probability (36% and 34% probability to *S. juliae*). One *S. pringlei* specimen was placed a posteriori into the *S. juliae* group with 51% probability (40% to *S. juliae* and 9% to *S. chilensis*). Seventy of the 80 specimens of *S. chilensis* (90%) were assigned a posteriori to the *S. chilensis* group; 55 with 90-99% probability, 9 with 80-89% probability; 5 with 76-79% probability (18-21% to S. pringlei), and 3 64%, 59% and 56% probabilities (35%, 39% and 38% to *S. pringlei*). Eight specimens of *S. chilensis* were assigned a posteriori to other species: 5 to *S. pringlei* with 75-88% probability; 7 to *S. juliae* with 97% and 60% probabilities; and 1 to *S. argentinensis* with 100% probability. Eight of the 11 specimens of *S. juliae* (73%) were assigned a posteriori to the *S. juliae* group: 6 with 91-99% probability; 2 with 68% (32% to *S. pringlei*) and 65% (28% to *S. chilensis* and 8% to *S. pringlei*). Three specimens of *S. juliae* were assigned a posteriori to *S. pringlei* with 61%, 61% and 54% probability (38%, 38% and 46% to *S. juliae*). The two specimens of S. durangensis were assigned to *S. juliae* with 93% probability (7% to S. juliae) and 84% to S. pringlei (16% to S. juliae). The one *S. "aff. missouriensis"* specimen was assigned a posteriori to *S. pringlei* with 60% probability (28% to *S. chilensis* and 11% to *S. juliae*).

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of six a priori groups using upper stem leaf traits; a posteriori placements to groups in rows.

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*	*pringlei*	% correct
argentinensis	10	0	0	1	0	0	91
chilensis	1	72	2	0	0	5	90
juliae	0	0	8	0	0	3	73
missouriensis	1	0	0	15	0	0	94
paniculata	0	0	0	0	7	0	100
pringlei	0	0	1	0	0	10	91
Totals	12	72	11	16	7	18	90

Jackknifed classification matrix

Group	*argentinensis*	*chilensis*	*juliae*	*missouriensis*	*paniculata*	*pringlei*	% correct
argentinensis	10	0	0	1	0	0	91
chilensis	1	72	2	0	0	5	90
juliae	0	1	6	0	0	4	55
missouriensis	2	0	0	14	0	0	88
paniculata	0	0	0	0	7	0	100
pringlei	0	0	1	0	0	10	91
Totals	13	73	9	15	7	19	88

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for 120 specimens of *Solidago argentinensis*, *S. chilensis*, *S. juliae*, *S. missouriensis*, *S. paniculata*, and *S. pringlei*, and the two collections of *S. durangensis* and the one collections of *S.* aff. *missouriensis* are presented in Fig. 9. Eigen values on the first three axes were 7.212, 1.629, and 1.150.

Three taxon analysis

In the STEPWISE discriminant analysis of 102 specimens in three species level a priori groups *Solidago chilensis*, *S. juliae*, and *S. pringlei*, the following eight traits were selected and are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (19.47), ray floret lamina length (14.83), mid leaf width (9.68), disc floret cypsela body length at anthesis (8.81), outer phyllary length (6.97), number of mid leaf serrations (5.93), disc corolla lobe length (5.52), and mid leaf length (4.59). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 6. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *S. chilensis* and the two North American species *S. juliae* and *S. pringlei* (18.965 and 14.423, respectively) and the least separation was between *S. juliae* and *S. pringlei* (5.931).

Table 6. Between groups F-matrix for the thee a priori group analysis (df = 8, 92).

Group	*chilensis.*	*juliae*	*pringlei*
chilensis	0.000		
juliae	18.965	0.000	
pringlei	14.423	5.931	0.000

Wilks' lambda = 0.1589 df = 8 2 99
Approx. F = 13.6668 df = 16 184 prob = 0.0000

In the a posteriori Classificatory Discriminant Analysis of the three species level a priori groups plus the two specimens of *Solidago durangensis* and the one specimen of *S.* "aff. *missouriensis,*" *S. pringlei* was the only a priori group with 100% placement to that group a posteriori; a posteriori assignments for other groups ranged from 91-96% to their own groups. The Classification and Jackknife Classification matrices are presented in Table 7. Results are presented in decreasing order of percent correct placement. Seven of 11 specimens of *S. pringlei* were placed a posteriori into the *S. pringlei* group with 90-100% probability; 3 with 77%, 76% and 74% (22% to *S. juliae*, 23% to *S. chilensis*, and 25% to *S. juliae*, respectively). Seventy-seven of the 80 specimens of *S. chilensis* (96%) were assigned a posteriori to the *S. chilensis* group; 70 with 90-100% probability, 4 with 81-88% probability; and 3 with 77%, 68% and 67% probabilities (23% to *S. pringlei*, 32% to *S. juliae*, and 21% to *S. pringlei* and 13% to *S. chilensis*). Three specimens of the *S. chilensis* group were assigned a posteriori to *S. pringlei* with 90%, 59% and 51% probabilities (10% to *S. chilensis*; 39% to *S. chilensis* and 10% to *S. juliae*; and 25% to *S. chilensis*

and 16% to *S. juliae*; respectively). One specimen of *S. durangensis* was assigned to *S. pringlei* with 98% probability and one was assigned to *S. juliae* with 56% probability (44% to *S. pringlei*). The one *S. "aff. missouriensis"* specimen was assigned a posteriori to *S. chilensis* with 95% probability (4% to *S. pringlei* and 1% to *S. juliae*).

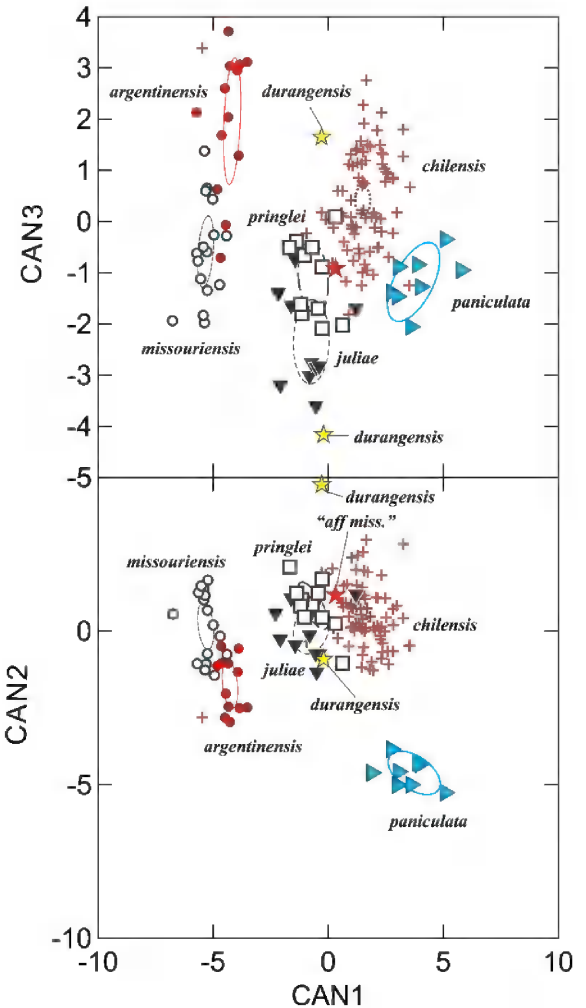

Figure 9. Plots of CAN1 versus CAN3 and CAN1 versus CAN2 of 136 specimens included in the second six a priori groups analysis: *Solidago argentinensis* (red dots) and *S. missouriensis* (circles) of subsect. *Junceae*, *S. paniculata* of subsect. *Maritimae*, *S. chilensis* (brown +), *S. juliae* (black triangles) and *S. pringlei* (white squares with black outlines) of subsect. *Tripinerviae*, and two collections of *S. durangensis* (yellow stars) and one collection of "aff. *missouriensis*" (red star) that is likely an aberrant *S. pringlei*; STEPWISE analysis with upper stem leaves; 95% confidence ellipses are shown for each group.

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*chilensis*	*juliae*	*pringlei*	% correct
chilensis	77	0	3	96
juliae	0	10	1	91
pringlei	0	0	11	100
Totals	77	10	15	96

Jackknifed classification matrix

Group	*chilensis*	*juliae*	*pringlei*	% correct
chilensis	74	3	3	93
juliae	0	9	2	82
pringlei	1	1	9	82
Totals	75	13	14	90

A two dimensional plot of CAN1 versus CAN2 canonical scores for 102 specimens of *Solidago chilensis*, *S. juliae*, *S. pringlei*, and the two collections of *S. durangensis* and the one collection of *S. "*aff. *missouriensis"* are presented in Fig. 10. The positions of the two *S. durangensis* specimens and one *S. "*aff. *missouriensis"* specimen are indicated by two yellow stars and one red star, respectively. Eigen values on the first two axes were 2.209 and 0.492.

DISCUSSION

The results support Nesom's (1993) inclusion of *Solidago durangensis* in subsect. *Triplinerviae* but do not support his (Nesom 1991) protologue comparison with *S. paniculata* of subsect. *Maritimae*. Also, Semple's 2013-2016 (Astereae Lab web site of that time period) placement of *S. durangensis* in subsect. *Junceae* is not supported. The two specimens of *S. durangensis* were assigned a posteriori in the classificatory discriminant analyses to *S. chilensis, S. pringlei,* or *S. juliae* with high probabilities in the three analyses. These species are all members of subsect. *Triplinerviae*. The *S. durangensis* specimens were never assigned to species of subsect. *Junceae* or subsect. *Maritimae*. Additional specimens of *S. durangensis* are needed in order to be able to include them in an analysis as their own a priori group. The limited number of collections that Nesom (1991) and we saw for this study were all collected in 1896. A search of the Durango, Mexico, area is needed to determine if the species is still extant. The two specimens of *S. durangensis* did not cluster tightly together in the three analyses. Both specimens were incomplete shoots, which may have resulted in the leaves scored being at upper and lower ends of the ranges of variation for these traits and subsequent differences in canonical scores involving these traits.

This is the first multivariate analysis that has included *Solidago durangensis*, *S. paniculata*, and species of the informal *Tortifolia* group of subsect. *Triplinerviae*. Lopez Laphitz and Semple (2015) did not include *S. pringlei* in their analysis, but Semple and Lopez Laphitz (2016) did. Specimens of *S. chilensis* were placed a posteriori more often into *S. pringlei* than *S. juliae* in all three of the analyses, although in each study the number was low. This indicates that *S. pringlei* shares more similarities with *S. chilensis* than *S. juliae*. All specimens of *S. pringlei* including the isotype of *S. muelleri* Standl. were placed a posteriori into *S. pringlei* only in the three species analysis of this paper, further supporting treating *S. muelleri* as a synonym of *S. pringlei*.

The placement of a specimen of *Solidago chilensis* into *S. argentinensis* was surprising because Lopez Laphitz et al. (2011) noted this did not happen in an analysis that they had run on just *S. argentinensis*, *S. chilensis*, and *S. microglossa*. Lopez Laphitz et al. (2011) and Lopez Laphitz and Semple (2015) included some very short specimens of *S. chilensis* that on stem height alone might be

misidentified as *S. missouriensis*. Also, some specimens of *S. chilensis*, e.g. the shorter shoot on *Nesom & Morgan 5302* (TEX) have pairs of lateral branch leaves, a feature typical of, but thus not exclusive to, subsect. *Junceae*.

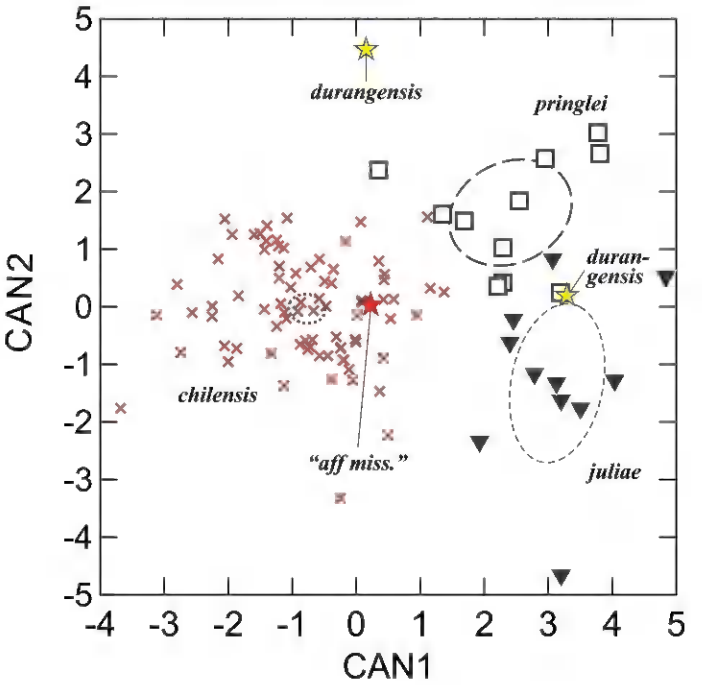

Figure 10. Plots of CAN1 versus CAN2 of canonical scores for 136 specimens of *Solidago chilensis* (brown +), *S. juliae* (black triangles) and *S. pringlei* (white squares with black outlines), and two collections of *S. durangensis* (yellow stars) and one collection of aff. "*missouriensis*" (red star) that is likely an aberrant *S. pringlei*; 95% confidence ellipses are shown for each group.

Multivariate analyses based on the sizes and numbers of parts can sometime yield unexpected results because the traits show some variation due to environmental factors or due to stem damage. This is likely the explanation for a specimen of *Solidago chilensis* being weakly assigned a posteriori in the first analysis to *S. paniculata*, which is the central Mexican endemic species of subsect. *Maritimae*. The *S. chilensis* plant (*Thüngen 127*, LP) came from General Alvarado, Buenos Aires Prov., Argentina, and had lower stem leaves and leaf bases typical of subsect. *Triplinerviae*, i.e., not the largest and without sheathing leaf bases typical of subsect. *Martimae*. In the second analysis, the same specimen was placed a posteriori into *S. chilensis* with 99% probability. Multiple analyses emphasizing different traits can be a useful way to clarify surprising results in one analysis.

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LIRIOPE AND *OPHIOPOGON*: OVERVIEW OF TWO GENERA OF RUSCACEAE NATURALIZED IN THE ARKANSAS FLORA

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ABSTRACT

Liriope muscari (Dcne.) L.H. Bailey and *Ophiopogon japonicus* (Thunb.) Ker–Gawl. are first reported here as naturalized in the Arkansas flora, with *Liriope graminifolia* (L.) Baker documented in multiple instances as aggressively spreading from cultivated plants via stoloniferous offsets. The *O. japonicus* record represents the first documented occurrence of the genus *Ophiopogon* in the state outside of cultivation and naturalized. Seven distinct populations of *O. japonicus*, ranging from about 10 plants to 100s of individuals and/or ramets, were discovered along a ca. 3/10 of a mile (530 m) stretch of a small, intermittent stream in a disturbed riparian habitat in Clark County, Arkansas. An additional small population of *O. japonicus* was documented along a second, distinct riparian zone, which is separated from the preceding by over 2 km. One naturalized population of *O. japonicus* also was documented from Pulaski County. Naturalized plants of *Liriope muscari* are documented from Clark, Garland, and Pulaski counties. Naturalized plants and populations of *L. spicata* Lour. are documented from several locations in Clark, Garland, Hot Spring, and Pulaski counties. Based on these observations, it is reasonable to surmise that species of *Liriope* and *Ophiopogon* are considerably more widespread in the state than current records indicate. Keys for identification of Arkansas species of *Liriope* and *Ophiopogon*, photographs of plants in habitat, and notes on both genera in Arkansas are provided.

The Ruscaceae or ruscus family consists of about 28 genera and 500 species of mostly herbaceous monocots distributed over Africa, Asia, Europe, and North America (Weakley 2015). The Arkansas flora boasts 5 genera and 8 species; three genera: *Convallaria*, *Liriope*, and *Ophiopogon* are non–native and of Asiatic origin. A number of *Liriope* and *Ophiopogon* species have become naturalized to various degrees in the USA, although they have received only minimal attention in floristic studies and often are not well–represented in herbaria (Utech 2002; Nesom 2010; Spaulding et al. 2010). For a comprehensive treatment of the species in both genera that are cultivated and naturalized in the USA, see Nesom (2010).

Several species of *Liriope* and *Ophiopogon* are important ornamentals in warm–temperate climates, and frequently are used as ground covers or for borders because of their high shade tolerance, ease of propagation, and hardy, vigorous, and evergreen habit (Bailey & Bailey 1976; Fantz 2008b, 2009). Species in both genera are sometimes collectively referred to as "liriopogons" (Skinner 1971; Fantz 2008b).

Ophiopogon contains about 65 species of herbaceous perennials native to Asia (Chen & Tamura 2000b). *Ophiopogon* species are caespitose or stoloniferous/rhizometous, tightly–leaved, and grass–like in appearance. The flowers are purple, lavender, pink, or white, with six tepals and stamens and a single pistil. The fruit is a small, leathery capsule that dehisces early in development to expose young seeds. At maturity, the seeds are berry–like, with blue or black sarcotestas (Cutler 1992; Chen & Tamura 2000a, 2000b; Fantz 2008a). *Ophiopogon japonicus* (Thunb.) Ker–Gawl. is regularly cultivated in Arkansas; naturalized plants are documented here from two counties.

Liriope, also Asiatic in origin, is closely related and morphologically similar to *Ophiopogon* and includes about 8–12 species (Chen & Tamura 2000a; Nesom 2010). More than one–half of the species from both genera are native to China (Chen & Tamura 2000a, 2000b; Nesom 2010). *Liriope muscari* (Dcne.) L.H. Bailey and *L. spicata* Lour. are frequently cultivated and well–naturalized in the state, with *L. spicata* the most frequently encountered species outside of cultivation. *Liriope graminifolia* (L.) Baker, while not currently documented as a component of the naturalized flora, is regularly cultivated and has high potential for naturalization.

Escaped or naturalized plants regularly are encountered spreading directly from cultivated individuals or in the vicinity of areas where plants of the same species occur in cultivation. It is important to note, however, that many of our records are of plants that, although present in urban environments, are clearly naturalized without direct (obvious) connection to cultivated plants. Naturalized species of *Liriope* and *Ophiopogon* appear to favor disturbed, urban woods or green belts and riparian zones that offer some amount of disturbance, moist soils, and at least partial shade. In this report, we newly document the presence of naturalized plants in both genera from multiple Arkansas counties. Based on our observations, species of *Liriope* and *Ophiopogon* are stable components of the state's flora. This paper is a floristic overview of two non–native genera of Ruscaceae in the Arkansas flora.

Liriope and *Ophiopogon* establish in the Arkansas flora via asexual reproduction (Fig. 1). With age, stolons bearing offsets deteriorate and separate from the originating genet (Fantz 2008a). Over time, spread and subsequent establishment via stoloniferous offsets occurs, giving rise to escaped individuals and naturalized colonies. Fruit and seed production also occur with both genera, and some establishment of *Liriope* (and probably also *Ophiopogon*) in Arkansas occurs from fruits and seeds (Fig. 2). Spaulding et al. (2010) noted that spread and establishment of *Liriope* and *Ophiopogon* in the Alabama flora occurs through fragmentation of stoloniferous offsets and water–mediated dispersal of seeds. Larger populations or colonies of these species present in the Arkansas

flora may represent a single clone and/or a mixture of multiple plants derived from a combination of asexual and sexual reproduction.

Figure 1. Asexual reproduction in *Liriope spicata*. (A) Stoloniferous offsets produced from a large, naturalized colony of *L. spicata* along a riparian zone in Clark County. (B) Stolons/rhizomes and tuberous roots.

Figure 2. Sexual reproduction in *Liriope muscari*. (A–B) Spontaneous seedlings and juvenile plants from Clark County; a close–up of two seedlings may be seen in Fig. A, as indicated by the yellow–colored arrows. Seventeen additional juvenile plants from the same location in various stages of development are shown in Fig. 2B (photo credit: Renn Tumlison); additional spontaneous plants were present at this location. (C) Seeds with sarcotestas removed.

Arkansas species of *Liriope* and *Ophiopogon* are morphologically similar and easily confused, especially in regard to sterile or vegetative material. Reproductive structures (inflorescences, flowers, and fruits/seeds) are best used for species separation (Nesom 2010). Escaped or naturalized species that may currently be encountered in the Arkansas flora are distinguished using the following key (modified from Nesom 2010).

1. Pedicels of flowers recurved (flowers drooping); flowers perigynous or epigynous; anthers connate; fruits (seeds) blue ..... **Ophiopogon japonicus**
1. Pedicels of flowers straight (flowers held erect); flowers hypogynous; anthers free; fruits (seeds) black or dark blackish–blue.

2. Plants caespitose to occasionally weakly stoloniferous, clump–forming and not spreading aggressively via stoloniferous offsets ..... **Liriope muscari**
2. Plants highly stoloniferous, clearly forming large, extensive colonies via stoloniferous offsets.

3. Inflorescences usually as tall or taller than the leaves, rachis of inflorescence (4–)5–13 cm long, flowers purple, lilac, or lavender ..... **Liriope graminifolia**
3. Inflorescences clearly shorter than the leaves and often obscured by them, rachis of inflorescence 2–5(–8) cm long, flowers white to pale pink or pale violet ..... **Liriope spicata**

CATALOG OF *LIRIOPE* AND *OPHIOPOGON* SPECIES

1. Liriope graminifolia (L.) Baker – GRASS LILYTURF, CREEPING LILYTURF (Fig. 3).

Liriope graminifolia, is a stoloniferous perennial that is native to China, Pakistan, Taiwan, and Vietnam (Chen & Tamura 2000a; Nesom 2010). In the USA, it previously only has been documented outside of cultivation in Texas (Nesom 2010). It is regularly cultivated in Arkansas and also much of the Southeast (Hume 1961; Fantz 2008a, 2009; Nesom 2010). Plants in cultivation typically produce extensive colonies via stoloniferous offsets. This tendency of *L. graminifolia* to aggressively spread from source plants provides legitimate potential for escape and naturalization into areas adjacent to where plants of the species are cultivated (Fig. 4). Case–in–point—about a decade ago, *L. graminifolia* was planted extensively on the Henderson State University campus as a border in a series of raised–bed planters. Currently, the planters are well–colonized with *L. graminifolia*, and plants continue to spread despite periodic mulching and mowing. A similar pattern of asexual spread by cultivated *L. graminifolia* was documented by Nesom (2010) on the Hendrix campus in Conway (Faulkner County). Based on its regular occurrence in cultivation and aggressive stoloniferous habit, *L. graminifolia* should be expected in the Arkansas flora, particularly in the vicinity of where it is cultivated.

In most characteristics, *Liriope graminifolia* overlaps with *L. muscari*, with the exception of its highly stoloniferous habit (Nesom 2010)—see discussion under *L. muscari* for additional information. In the field, extensive colonies of plants indicate *L. graminifolia* (or the similar *L. spicata*), whereas caespitose plants are *L. muscari*. Some forms of *L. muscari* are weakly stoloniferous but still produce a more or less caespitose growth form, rather than extensive colonies of plants. Young plants of *L. graminifolia* and *L. spicata* may sometimes initially appear caespitose but later will typically bear elongate stolons.

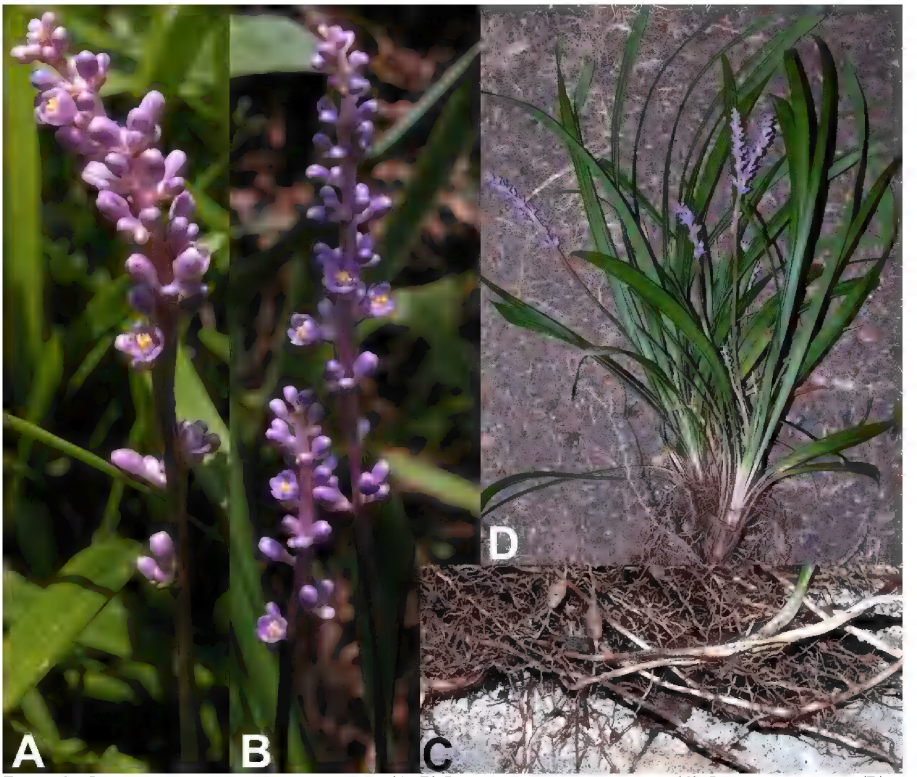


Figure 3. *Liriope graminifolia* plant and habit. (A–B) Inflorescences and flowers. (C) Stolons and roots. (D) Plant.

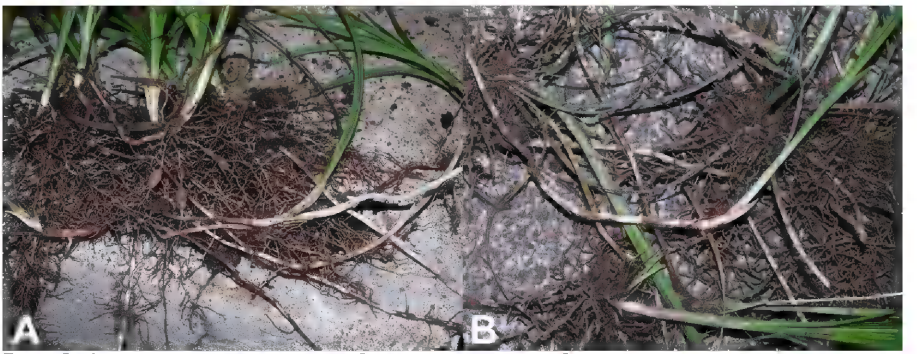


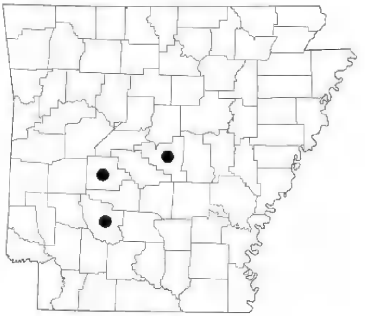
Figure 5. Comparison of sterile material of *Liriope graminifolia* and *L. spicata*; notice the close similarity in growth form and habit. (A) *Liriope graminifolia*. (B) *Liriope spicata*.

With regard to sterile material, *Liriope graminifolia* is easily confused with the widespread *L. spicata*, as both species produce expansive colonies via stoloniferous offsets and possess similar growth forms (Fig. 5). When reproductive, however, the two species easily are distinguished by flower color and height of inflorescence/infructescence in relation to leaf height. The flowers of *L. graminifolia* are lilac, pinkish–purple, or purple and the inflorescences are generally as tall or taller than the leaves. In contrast, the flowers *of L. spicata* are white or pale lilac and typically much shorter than the leaves, often partially obscured by them.

Figure 4. Plants of *Liriope graminifolia* spreading asexually via stoloniferous offsets in a raised–bed planter on the Henderson State University campus. The plants in the foreground (bottom of picture) were planted; however, every offset in the upper three–fourths of the photograph has spread from the originally cultivated plants. Several such plantings of *L. graminifolia* are present on the campus, with the plants showing similar patterns of spread.

Voucher specimens: **ARKANSAS**. Clark Co.: Hundreds of offsets/ramets present throughout raised–bed shrub planter (several similar planters with *L. graminifolia* are present on the HSU campus), plants have been present and have continued to aggressively spread for over a decade, 3 Jul 2016, *Serviss 8357* (HEND); numerous plants spreading aggressively (from stoloniferous offsets) from originally cultivated plants in shrub planting, HSU campus, Arkadelphia, 5 Aug 2005, *Serviss 6993* (HEND).

2. Liriope muscari (Dcne.) L.H. Bailey – BLUE LILYTURF, BIG BLUE LIRIOPE, MONKEY GRASS (Fig. 6).



Liriope muscari is a caespitose (clump–forming), sometimes weakly stoloniferous perennial that is native to China, Japan, and Taiwan (Chen & Tamura 2000a; Nesom 2010). It has previously been documented from Alabama, Georgia, Kansas, Louisiana, Maryland, Mississippi, Missouri, North Carolina, South Carolina, and Tennessee (Thomas & Allen 1993; Nesom 2010; Kartesz 2015; Weakley 2015). It is frequently cultivated in Arkansas, but until 2016 has not been documented outside of cultivation in the state. Our records of *L. muscari* from Clark, Garland, and Pulaski counties represent the first documented occurrences of this species in the state outside of cultivation (Fig. 7).

Both non–stoloniferous and weakly stoloniferous forms occur in the flora (Fig. 8). Based on our observations, the stoloniferous form produces a few, relatively short stolons but remains essentially caespitose, even over an extended period of many years. As Nesom (2010) noted, *L. muscari* and *L. graminifolia* are similar in nearly all characteristics, with the exception of the highly stoloniferous habit of *L. graminifolia*. Nesom speculated that some stoloniferous *L. muscari* could plausibly be forms of *L. graminifolia*, where the stoloniferous habit has been suppressed or restrained,

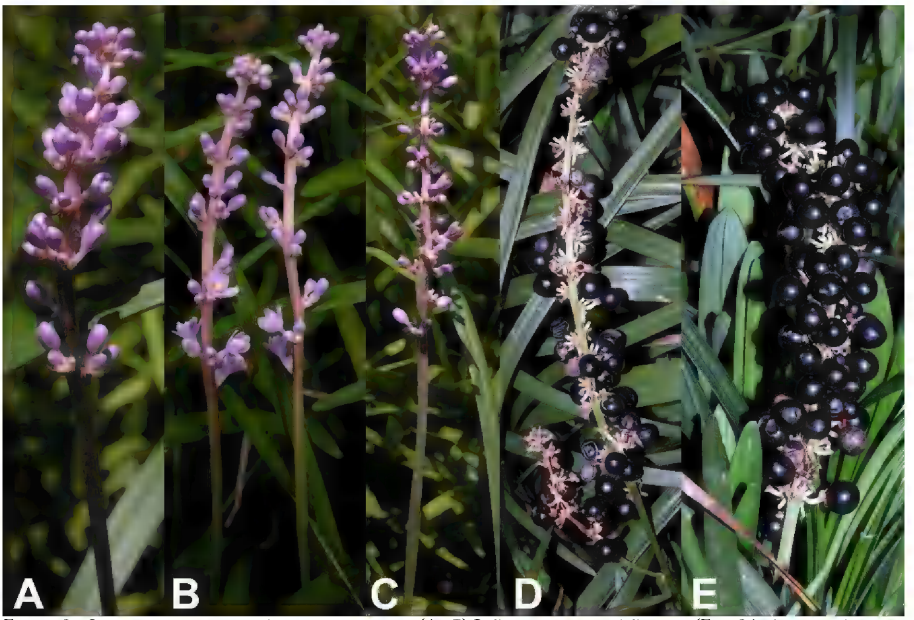


Figure 6. *Liriope muscari* reproductive structures. (A–C) Inflorescences and flowers (Fig. 6A shows a close–up view of the inflorescence). (D–E) Infructescences and mature fruits/seeds—the plants shown in Figs. 6B, D–E are the weakly stoloniferous form.

Figure 7. Escaped/naturalized plants of *Liriope muscari* from Clark and Pulaski counties. (A) Plant along a disturbed, semi-wooded roadside in Clark County. (B) Plant in disturbed, urban woods/green belt in Clark County; several naturalized plants of *L. muscari* were present at this location. (C) Possibly escaped individual from a residence in Arkadelphia. (D) Plant growing in a low area of disturbed, urban woods in Pulaski County; three plants of *L. muscari* were present at this location.

and suggested that evidence for this might be clarified through molecular studies. In Arkansas, the weakly stoloniferous form of *L. muscari* produces fruit, sometimes heavily so, and spontaneous seedlings sometimes are observed in the vicinity of where fruiting plants occur (Fig. 2). Fantz (2008b) noted that abundant fruit set is a trait of *L. graminifolia*, rather than *L. muscari*.

Escaped plants of *Liriope muscari* were observed in lawns, flower beds, shrub plantings, and along walkways. Naturalized plants of *L. muscari* also were regularly observed in urban woods and green belts that occur in proximity to areas where *L. muscari* was cultivated. Presumably seeds are dispersed to these areas by birds and/or water.

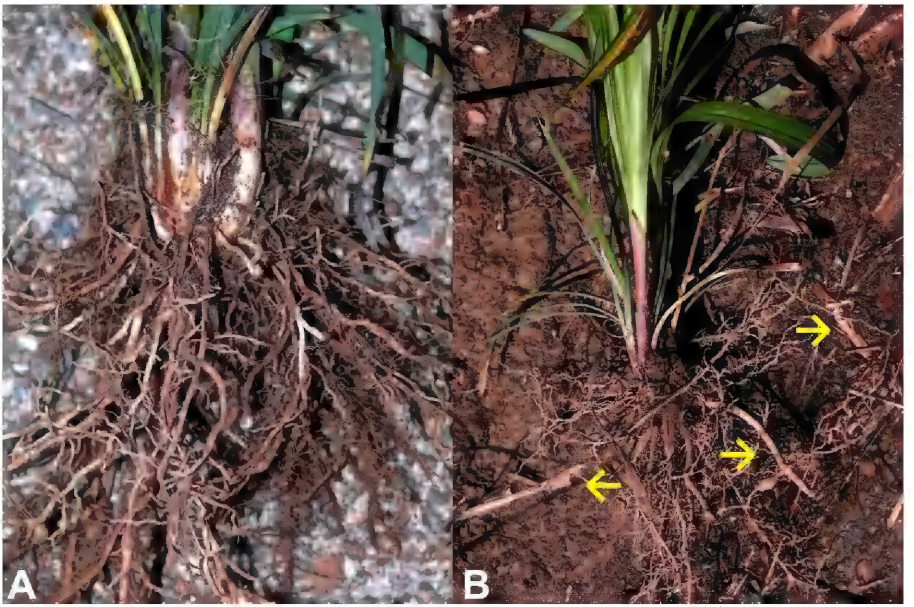
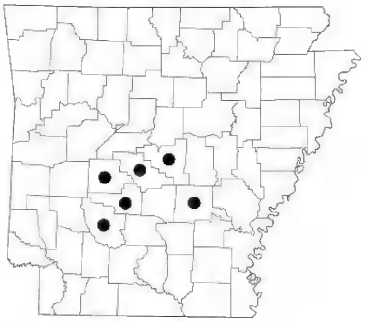


Figure 8. *Liriope muscari*: comparison of stoloniferous and non–stoloniferous forms. (A) Plant without stolons (the white–colored structures that are reminiscent of such are actually roots). (B) Plant with short but well–developed stolons—stolons are indicated by the yellow–colored arrows. This plant is an escaped individual from Clark County. Based on our observations of Arkansas plants of *L. muscari*, stoloniferous plants produce only a relatively few number of short stolons and maintain an overall caespitose growth from, even over many years.

Voucher specimens: **ARKANSAS**. Clark Co.: One possibly spontaneous (escaped) plant at base of tree in sandy, rocky soil, residence at 1318 O'Connell St., N34.11561, E-93.063618, Arkadelphia, 22 Jun 2016, *Stone 2016–2* (HEND); several (ca. 8) spontaneous plants in disturbed, semi–unkempt area next to church building, many cultivated plants of the species in the vicinity, off Country Club Rd. at the intersection of Country Club Rd. and W.P. Malone Dr., Arkadelphia, 4 Jun 2016, *Serviss 8343* (HEND); one naturalized plant on roadside, non–stoloniferous form, semi–wooded with high disturbance, Clinton St. adjacent to the intersection of Clinton St. and 26th St., Arkadelphia, 28 May 2016, *Serviss 8342* (HEND); five scattered, naturalized plants—plants stoloniferous but caespitose, in highly disturbed urban woods/green belt and riparian zone, off O'Connell St. adjacent to the intersection of O'Connell St. and 18th St., Arkadelphia, 14 May 2016, *Serviss 8336* (HEND); nearly two dozen escaped/spontaneous, juvenile plants (from seeds) in lawn and highly disturbed areas around walkway, numerous cultivated plants of the species in the immediate vicinity, residence, 1900 block of Sylvia St. Arkadelphia, 3 May 2016, *Serviss 8232* (HEND). Garland Co.: One naturalized clump of plants in flower, plant with short stolons, about 4 feet from creek in moist, rocky soil, numerous plants of the species also cultivated in the area, Hot Springs Creek at Hollywood Park off Hollywood Ave., Hot Springs, N34.29127, E-93.02815, 26 Jun 2016, *Olsen 2*; a few plants along a wooded stream with many exotics, off Carpenter Dam Road, Cherokee Beach development, SW Hot Springs, 22 Jul 2006, *Peck 06–033* (HEND). Pulaski Co.: Three widely separated naturalized plants, non–stoloniferous form, in low area with moist soils in semi–disturbed, urban woods adjacent to the intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8234* (HEND).

3. Liriope spicata Lour. – CREEPING LILYTURF, CREEPING LIRIOPE, MONKEY GRASS (Figs. 9–10)



Liriope spicata Lour. is a stoloniferous perennial that is native to China, Japan, Korea, Taiwan, and Vietnam (Chen & Tamura 2000a; Nesom 2010). It previously has been documented from Alabama, Arkansas, Florida, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Illinois, and Texas (Nesom 2010; Wunderlin & Hansen 2011; Gentry et al. 2013; Kartesz 2015; Weakley 2015). In Arkansas, *L. spicata* has previously been documented from three counties in central Arkansas: Jefferson, Pulaski, and Saline (Gentry et al. 2013). We add three new county records to its distribution: Clark, Garland, and Hot Spring. Based on our observations, however, *L. spicata* is likely more widespread in the state than its current known distribution.

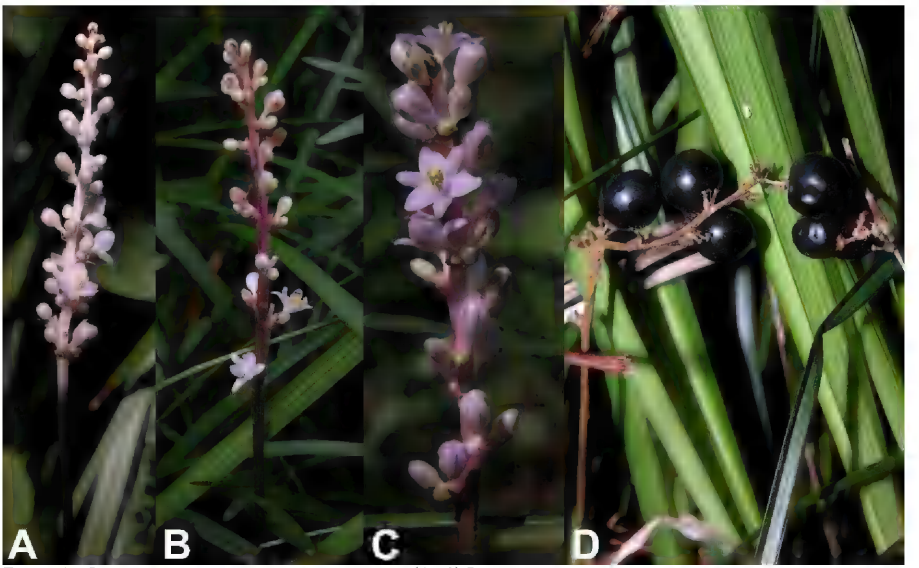


Figure 9. *Liriope spicata* reproductive structures. (A–C) Inflorescences and flowers showing some of the variation in flower color that may be encountered — flowers of *L. spicata* may range in color from white to pale lilac (Fig. 9C shows a close–up view of the inflorescence). (D) Infructescence and mature fruits/seeds.

In the flora, *Liriope spicata* was observed at several locations in large numbers, with plants clearly spreading vegetatively via stoloniferous offsets (Figs. 11–12). In regard to these large populations or colonies that consist predominately of ramets, it was outside the scope of this study to determine whether these populations might represent a single clone, combinations of multiple clones, or some mixture of both sexually and asexually derived plants. Fruiting plants and putative seedlings also were observed in some locations; hence, some establishment also probably occurs via seeds (Fig. 13). Naturalized *L. spicata* is regularly encountered in disturbed urban woods, green belts, and

riparian zones. In these habitats, *L. spicata* should be considered invasive. It also is long–persistent subsequent to cultivation practices and often observed spreading vegetatively from cultivated plants.

Figure 10. *Liriope spicata* showing well–developed stolon/rhizome, tuberous roots, and fibrous root system.

Figure 11. Naturalized plants of *Liriope spicata* from Clark County. This population extends beyond what is shown in the photograph and consists of hundreds of (or possibly more) offsets (ramets). The principal means of spread appears to be via stoloniferous offsets, but some establishment also may be occurring via seeds, as plants with spent infructescences were present. Several similar populations occur along Mill Creek and elsewhere in Arkadelphia.

Figure 12. Naturalized plants of *Liriope spicata* from Clark County. This large population occurs at the top of a slope at the edge of a wooded ravine in Arkadelphia, and extends much beyond what is show in the photograph. Similar to that shown in Fig. 11, most of the establishment appears to be asexual. It consists of possibly thousands of ramets. This location is densely shaded.

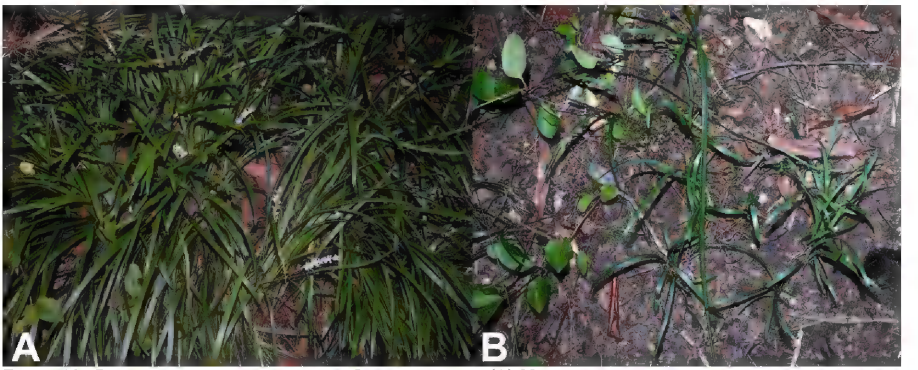
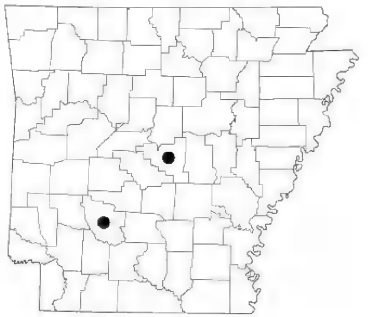


Figure 13. Possible sexual reproduction in *Liriope spicata*. (A) Naturalized plants growing in a wash on a steep slope in an urban greenbelt. (B) Several, small juvenile individuals produced presumably from seeds generated by the plants shown in Fig. 13A. These juveniles occur in a mostly flat area a few dm down slope at a nearly vertical drop from the mature plants shown in Fig. 13A. Direct production from stoloniferous offsets was not likely the source of the juvenile plants. However, even though seeds are the presumed propagule, asexual spread via stolons cannot completely be excluded, because fragmentation and subsequent dispersal of stoloniferous offsets can occur.

Voucher specimens: **ARKANSAS**. Clark Co.: Large colony of naturalized plants growing in low, wet depression and drainage, highly disturbed, open woods, off of Pinewood Dr., SE of intersection of Pinewood Dr. and 10th St, 3 Jul 2016, *Serviss 8356* (HEND); extensive, naturalized population consisting of numerous colonies and individual plants along embankment and overflow area, with many plants also extending to near edge of stream, disturbed, semi–wooded riparian zone adjacent to HSU campus, directly S of Mill Creek Dr. and Feaster Trail between 12th St. and 15th St., Arkadelphia, 3 Jul 2016, *Serviss 8353* (HEND); a few large colonies of plants in and at edge of highly disturbed, urban woods, NW of Reddie Athletic Center, HSU campus, Arkadelphia, 17 Jun 2016, *Serviss 8357* (HEND); one large colony of naturalized plants and a few additional isolated individuals, disturbed, urban woods and riparian zone, off University Ave. adjacent to the intersection of University Ave. and 10th St., Arkadelphia, 17 Jun 2016, *Serviss 8348* (HEND); a few naturalized colonies and isolated plants on and below wash and slope in disturbed, urban woods/green belt and riparian zone, HSU/OBU Ravine, off 8th St. adjacent to the intersection of 8th St. and McNutt St., Arkadelphia, 16 Jun 2016, *Serviss 8347* (HEND); three colonies of naturalized plants at edge and within disturbed, urban woods/green belt, directly NE of Arkadelphia Medical Clinic, off Pine St., Arkadelphia, 15 Jun 2016, *Serviss 8345* (HEND); several large and small colonies of naturalized plants in highly disturbed, urban woods adjacent to residential area, Feaster Trail area, off 15th St. adjacent to the intersection of 15th St. and Mill Creek Dr., Arkadelphia, 26 May 2016, *Serviss 8341* (HEND); several naturalized plants in semi–unkempt lawn area and under shrubs, many of the plants juveniles apparently from seeds, NW side of the Reynolds Science Building, HSU campus, Arkadelphia, 18 May 2016, *Serviss 8338* (HEND); several large, naturalized colonies of plants along highly disturbed riparian zone, plants with fruits, Mill Creek, Feaster Trail area E of 26th St., Arkadelphia, 15 Oct 2015, *Serviss 8199* (HEND); small colony of plants naturalized in disturbed, urban woods, adjacent to the intersection of 12th St. and Huddleston St., Arkadelphia, 28 Aug 2014, *Serviss 8174* (HEND); numerous plants naturalized on wooded slope along Mill Creek, adjacent to the intersection of Twin Rivers Dr. and Cypress Rd., Arkadelphia, 4 Sep 2014, *Serviss 8178* (HEND); large colony of many plants growing on disturbed, semi–wooded bank of stream, spreading vegetatively via stolons, Mill Creek, Feaster Trail area off 15th St. and Mill Creek Dr., Arkadelphia, 8 Oct 2013, *Serviss 8075* (HEND). Garland Co.: Small colony of naturalized plants at edge of creek, with some plants growing over concrete rubbish, Hot Springs Creek at Olive St. and Transportation Depot, N34.30390, W-93.03100, 8 May 2016, *Olsen 1* (HEND); numerous escaped plants in woods and ditches, Brecklins' Corner, Golf Links Rd. and Shady Grove Rd., SE Hot Springs, 2 Sep 2006, *Peck 06–278* (HEND). Hot Spring Co.: Extensive colony of naturalized plants along open roadside and adjacent ditch, plants apparently spreading and escaped from cultivated plants in the vicinity, Smoke Ridge Rd., coming from Hwy. 51, N34.454176, E-92.851663, Jun 22 2016, *Stone 2016–2* (HEND). Pulaski Co.: Two small colonies of naturalized plants in semi–disturbed, urban woods, adjacent to the intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8235* (HEND); naturalized plants in floodplain woods, Arkansas River floodplain, Two Rivers Park, W of Little Rock, sandy soils, 5 Aug 2007, *Peck 07–1799* (HEND); naturalized plants in waste areas, ditches, and wooded drainage areas, Coleman Creek, Little Rock, 10 Sep 2006, *Peck 06–278* (HEND).

4. Ophiopogon japonicus (Thunb.) Ker–Gawl. – JAPANESE MONDO GRASS, DWARF MONDO GRASS (Figs. 14–15).



Ophiopogon japonicus is a stoloniferous perennial that is native to China, Japan, Korea, and Taiwan (Chen & Tamura 2000b; Nesom 2010). It previously only has been documented outside of cultivation in four states: Alabama, Mississippi, North Carolina, and Texas (Diggs et al. 1999; Nesom 2010; Spaulding et al. 2010; Roling et al. 2011; Weakley 2015). The genus previously was attributed to Arkansas (Smith 1988; Arkansas Vascular Flora Committee 2006); however, it was based on misidentified material of *L. spicata* (Nesom 2010; Gentry et al. 2013). Hence, our records of *O. japonicus* from Clark and Pulaski counties represent the first documented occurrences of the genus *Ophiopogon* in the state outside of cultivation and apparently only the fifth state–level occurrence in the USA.

In 2014 and 2016, a total of seven, distinct populations of naturalized *Ophiopogon japonicus* were documented in a highly disturbed, urban woods and riparian zone along a ca. 530 m stretch of a small, intermittent stream in Clark County (Figs. 16–18). The populations ranged in size from about 10 plants to hundreds of plants/ramets in the largest. Plants occurred along the stream edge, embankment, and the overflow areas above. Plants were observed spreading via stoloniferous offsets; however, some plants had mature fruits, indicating that some establishment also may have occurred via seeds (Fig. 14). All plants were one of the dwarf forms of *O. japonicus*, which only reach a height of ca. 5–10 cm. The dwarf forms are derived from larger, wild–type plants (Nesom 2010).

It is important to note that three of the seven *Ophiopogon japonicus* populations occur upstream and are somewhat separated from the other four. These populations occurred in large, expansive colonies directly above the bank in the overflow area and may possibly have been long–persistent from cultivation practices, as the entire site is surrounded by residential areas. The location of these populations may have been an old home site, although no obvious evidence of such is currently present and the area is subject to periodic flooding and remains wet for long periods of time. One possible explanation as to the origin of the four downstream populations is that propagules, such as seeds, stolon segments or offsets, or whole plants were transported downstream by birds (seeds) and/or water, allowing establishment of the naturalized populations.

In 2016, an additional small population of a few–dozen naturalized plants was discovered along a second, distinct riparian zone. This location is separated from the preceding by more than 2 km, but is similar in regard to level of disturbance. Plants were present along the base of the streambank, with some individuals occurring almost within the streambed. Plants were spreading via stoloniferous offsets and also possibly by seeds, as a number of plants occurred as isolates or small, widely–separated clusters. Some plants were reproductive with spent inflorescences.

In 2015, a single naturalized population of *Ophiopogon japonicus* was discovered in Pulaski County growing along a natural seep in semi–disturbed, urban woods (Fig. 19). Again, as observed typically with *L. spicata* (and the Clark County populations of O. *japonicus*), the Pulaski County population consisted largely or wholly of stoloniferous offsets, and most establishment appeared to be asexual. The Pulaski County plants were not the dwarf form. In Arkansas, *O. japonicus* occurs in disturbed, urban woods and greenbelts, woodland edges, and riparian zones, particularly in moist to wet soils.

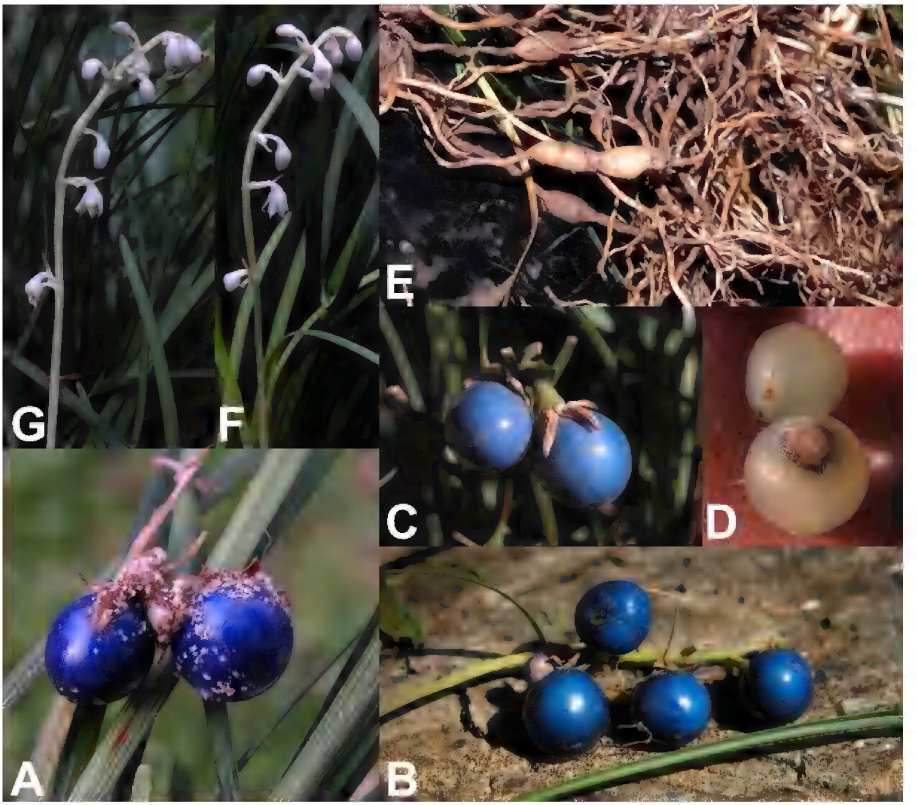


Figure 14. *Ophiopogon japonicus* reproductive structures and tuberous roots. (A–C) Mature infructescences and mature fruits/seeds; the seeds in Fig. 14C are lighter in color than those in in Figs. 14A–B. (D) Seeds with sarcotestas removed. (E) Tuberous roots. (F–G) Inflorescences and flowers—notice the downward oriented and curved pedicels of the flowers (the flowers of *O. japonicus* sometimes have more pink coloration than what is shown in Figs. 14F–G).

Figure 15. *Ophiopogon japonicus* plants, stolons/rhizomes, and tuberous roots (from cultivated plants).

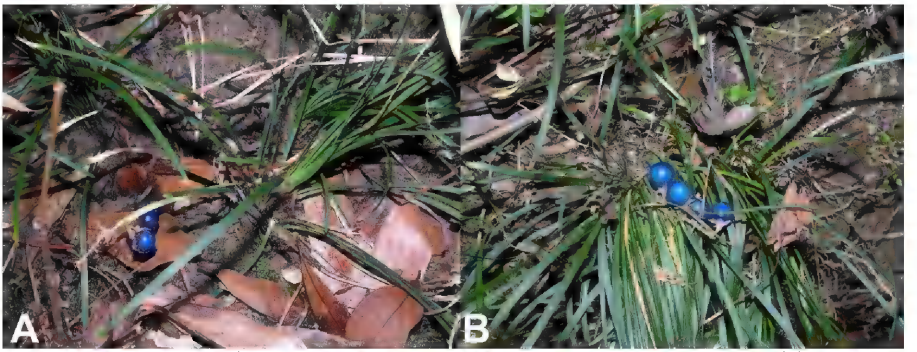


Figure 16. Naturalized, fruit/seed–bearing plants of *Ophiopogon japonicus* from Clark County. (A) Individual from one of the smaller naturalized populations; a few plants from this population were reproductive with mature fruits/seeds. (B) Larger individual (from a different population than the plant shown in Fig. 16A). These plants are one of the dwarf forms of the species.

Figure 17. Small population of naturalized individuals of *Ophiopogon japonicus* from Clark County. The lowermost plants in the photograph are just above the waterline of a small stream in a disturbed riparian zone, and would be temporarily inundated during periods of high water flow.

Figure 18. Largest of the four downstream naturalized populations of *Ophiopogon japonicus* from Clark County. Several large clusters of dark green–colored plants may be seen, both directly above the water line and higher up on the streambank. As previously mentioned with *Liriope spicata*, it is unknown whether or not the ramets making up much or all of this population represent a single clone or were generated from multiple, distinct individuals. Numerous ramets produced from stoloniferous offsets even extend above the bank into the taller vegetation at the top of the photograph.

Figure 19. Naturalized plants of *Ophiopogon japonicus* from Pulaski County. The boundaries of this population extend much beyond what is shown in the photograph. This population was present growing along a seep in very moist soil in semi–disturbed, urban woods in Little Rock (Pulaski County). These plants are not one of the dwarf forms.

Voucher specimens: **ARKANSAS**. Clark Co.: Small population of a few dozen plants and offsets at edge of stream in disturbed, semi–wooded riparian zone, some plants growing almost in streambed, plants with spent flowers present, adjacent to HSU campus, directly S of Mill Creek Dr. and Feaster Trail between 12th St. and 15th St., Arkadelphia, 3 Jul 2016, *Serviss 8355* (HEND); four naturalized colonies of plants along a ca. 0.2 mi stretch of a highly disturbed woods and riparian zone, some plants with fruits, distributed between 19th St. and 23rd St. about 1 block N of Crawford St., 18 Apr 2016, *Serviss 8227* (HEND); small colony of a few dozen plants growing at edge and along bank of small stream in a disturbed, semi–wooded riparian zone, plants with fruits, off 23rd Street, ca. 1 block N of the intersection of 23rd St. and Crawford St., 22 Feb 2016, *Serviss 8210* (HEND); three large colonies of plants along highly disturbed, open and semi–wooded right–of–way adjacent to small stream, off 23rd St., ca. 1 block N of the intersection of 23rd St. and Crawford St., 14 Feb 2014, *Serviss 8103* (HEND). Pulaski Co.: Large colony of probably 100s of plants at edge and along seep in semi–disturbed, urban woods, very moist soil, adjacent to intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8233* (HEND).

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COMPOSITAE OF CENTRAL AMERICA–IV. THE GENUS *EREMOSIS* (VERNONIEAE), NON-GLANDULAR TRICHOMES AND PERICARP CRYSTALS

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ABSTRACT

The nine Central American species of the Mexican and Central American endemic genus *Eremosis* (Vernonieae) are revised. New combinations validated are these: **Eremosis aristifera** (S.F. Blake) Pruski, **comb. nov.**, **Eremosis baadii** (McVaugh) Pruski, **comb. nov.**, **Eremosis corymbosa** (Mill.) Pruski, **comb. nov.**, **Eremosis feddemae** (McVaugh) Pruski, **comb. nov.**, **Eremosis macvaughii** (S.B. Jones) Pruski, **comb. nov.**, **Eremosis mima** (Standl. & Steyerm.) Pruski, **comb. nov.**, **Eremosis pugana** (S.B. Jones & Stutts) Pruski, **comb. nov.**, **Eremosis solorzanoana** (Rzed. & Calderón) Pruski, **comb. nov.**, **Eremosis standleyi** (S.F. Blake) Pruski, **comb. nov.**, **Eremosis thomasii** (H. Rob.) Pruski, **comb. nov.**, and **Eremosis villaregalis** (Carvajal) Pruski, **comb. nov**. Illustrated features useful in characterizing *Eremosis* include typically simple or infrequently T-shaped non-glandular trichomes, narrow-based pappus bristles, and a slight trend towards moderately elongate hexagonal pericarp crystals (raphides). Photographs of types or representative specimens are given for half a dozen species including *Conyza corymbosa* (which includes in synonymy the type of *Eremosis*) and *Turpinia tomentosa* (the type of synonymous *Turpinia*). In the second part of the present work, an annotated nomenclator of the 27 recognized species in *Eremosis* is given, and nine informal species groups are outlined in tabular form. Lectotypes are chosen for *Conyza corymbosa* Mill., *Eupatorium uniflorum* Sessé & Moc., and *Vernonia palmeri* Rose, and the typification of *Monosis salicifolia* DC. is discussed.

Eremosis (DC.) Gleason (1906) (Compositae: Cichorioideae: Vernonieae) is a mostly mid-elevational genus endemic to Mexico and Central America. *Eremosis* may be generally recognized by its woody habit including trees to 15+ meters tall, large compound paniculate capitulescences, uniflorous to few-flowered discoid capitula, and deciduous inner phyllaries (Jones 1973; Robinson 1993). The earliest generic name for *Eremosis* is *Turpinia* Lex. (Lexarza 1824; viz Fig. 12), but that is an illegitimate later homonym of *Turpinia* Vent. (Ventenat 1807). *Eremosis* was described as *Monosis* sect. *Eremosis* DC. (Candolle 1836) and characterized as uniflorous (the sectional name was derived from the Greek "*eremos*") (viz Figure 1, an original element of the type of *Eremosis*). Gleason (1906, 1922) treated *Monosis* sect. *Eremosis* at the generic rank as *Eremosis*, into which he also accepted pauciflorous species. *Monosis* DC. sensu stricto proves to be endemic to southern Asian and differs by lophate pollen (Robinson and Skvarla 2006). Other early generic names associated with *Eremosis* are *Oliganthes* Cass., which Pruski (1996) listed as endemic to Madagascar and *Gymnanthemum* Cass., given by Robinson (1999b) as an African and Asian native.

Gleason (1922) listed as 18 the number of species of *Eremosis* in Mexico and Central America, and treated *Critoniopsis* Sch. Bip. as a possible synonym. Jones (1973) recognized *Eremosis* as *Vernonia* sect. *Eremosis* (DC.) Sch. Bip., gave *Critoniopsis* in synonymy, and treated 20 species in his regional revision. Historically, *Eremosis* has also usually been treated as *Vernonia* sect. *Eremosis* (e.g., Schultz Bipontinus 1847, 1856; Bentham and Hooker 1873; Hoffmann 1890–1894; Blake 1917; Jones 1977; Turner 2007). Jones (1979a), Keeley and Turner (1990), and Smith and Coile (2007) recognized the group as *Vernonia* subsect. *Eremosis* (DC.) S.B. Jones. Species of *Eremosis* were treated as *Vernonia* Schreb. sensu lato and without infrageneric distinction in floristic works of Hemsley (1881), Blake et al. (1926), Standley (1938), Clewell (1975), D'Arcy (1975), Nash (1976), Villaseñor (1989), Rzedowski and Calderón de Rzedowski (1995a), and Keeley (2001). When recognized as *Vernonia*,

however, four names with priority (i.e., *E. corymbosa*, *E. foliosa*, *E. ovata*, and *E. tomentosa*) are confusingly blocked nomenclaturally in *Vernonia*.

Figure 1. Uniflorous *Eremosis corymbosa* (Mill.) Pruski, a reproduction of Sessé and Mociño, Icon. Flora Mex. 164, drawn between 1787–1803 [Illustr. Hunt Institute (Torner) 6331.0241; redrawn in black and white as Candolle plate 526 = Field neg. 30707; viz Sprague 1926; McVaugh 1980, 2000]. Icon. Flora Mex. 164 is a protologue element of each *Monosis salicifolia* DC., Prodr. 5: 77. 1836 and *Eupatorium uniflorum* Sessé & Moc., Pl. Nov. Hisp. 132. 1887 [1890]; Pl. Nov. Hisp. (ed. 2) 123. 1893. The number "19" on the upper portion of the plate refers to the Linnaean sexual system Class XIX Syngenesia. *Seriphium corimbosum* is an unpublished Sessé and Mociño name and *Shawia corymbosa*, in Candolle's hand, is also unpublished.

Robinson et al. (1980: 426) positioned *Eremosis* in Vernonieae subtribe Vernoniinae and *Critoniopsis* in the newly described subtribe Piptocarphinae. Similarly, when Schultz Bipontinus (1863) described *Critoniopsis* as new he did not relate it to what he earlier called *Vernonia* sect. *Eremosis* (Schultz Bipontinus 1847). Cuatrecasas (1956) and Robinson (1980) recognized *Vernonia* sect. *Critoniopsis* (Sch. Bip.) Benth. & Hook. f. and *Critoniopsis* as endemic to South America. More recently, Robinson (1993, 1999a) added *Eremosis* to synonymy with *Critoniopsis* and placed it in subtribe Piptocarphinae. Robinson characterized Piptocarphinae by readily deciduous inner involucral bracts, thus distinguished from *Vernonia* sensu stricto (subtribe Vernoniinae). Robinson (1993, 1999a) recognized 76–85 species of *Critoniopsis,* with the genus distributed from South America northward into Mexico. Turner (2007) recognized as 24 the number of Mexican species and treated them as *Vernonia* sect. *Eremosis.* Keeley et al. (2007: Fig. 2) and Keeley and Robinson (2009: Fig. 28.2) showed (*Keeley & Keeley 3161* determined as) *E. shannonii* (J.M. Coult.) Gleason in a clade containing *Stokesia laevis* (Hill) Greene and subtribe Leiboldiinae. At about the same time, Robinson (2007) and Haro-Carrión and Robinson (2008) suggested exclusion of *Eremosis* from synonymy with *Critoniopsis.* Keeley and Robinson (2009: Table 28.1) gave *Eremosis* as endemic to Mexico and *Critoniopsis* as found from Mexico to South America. Keeley and Robinson (2009) recognized 21 subtribes in Vernonieae. *Eremosis* was unplaced subtribally and as sister to a large clade containing most American genera including both *Critoniopsis* and *Vernonia*, the latter two treated in Piptocarphinae and Vernoniinae, respectively (Keeley and Robinson 2009). Nevertheless, Robinson et al. (1980) noted "some species of Piptocarphinae closely approach members of the Vernoniinae genus *Eremosis* in some characters."

Jones (1973) characterized *Vernonia* sect. *Eremosis* (i.e., *Eremosis*) as typically bearing only simple (rarely T-shaped) non-glandular trichomes (Figs. 2–3), supporting separation of *Eremosis* from *Critoniopsis* (Robinson 2009: 91; Mukherjee and Nordenstam 2012: 83). Robinson (2009: 91) gave T-shaped trichomes on herbage as characteristic of *Tephrothamnus* Sch. Bip., which has acute-tipped style branch sweeping papillae. This Venezuelan monotype seems recognizable by these trichome and papillae characters in combination with its glandular but never hirsute-pilose cypselae and its double pappus with the outer series of very short relatively membranous scales. The two species of *Eremosis* known to have T-shaped trichomes (*E. angusta* and *E. thomasii*) differ from *Tephrothamnus* by their combined characters (e.g., viz recommendation of Jones 1977) of eglandular setulose-substrigillose to pilose or pilose-hirsute cypselae with a simple pappus (Fig. 5A). These two species are provisionally maintained in *Eremosis* sensu Gleason (1922) and Jones (1973). Features other than kinds of non-glandular trichomes useful in distinguishing *Eremosis* from *Critoniopsis* include these: (1) relatively long, acute to obtuse-tipped style branch sweeping papillae (Robinson 1993: 607); (2) an isomorphic (vs. dimorphic with outer scales) pappus of relatively narrow-based bristles (Figs. 5–6); and (3) a slight trend towards moderately elongate hexagonal (vs. quadrangular or hexagonal) pericarp raphide crystals (Figs. 7–10). *Critoniopsis* and *Piptocarpha* of subtribe Piptocarphinae have short and blunt style branch sweeping papillae (Robinson 1993; Smith and Coile 2007: Fig. 7B).

Here, Mexican to Central American *Eremosis* is recognized as distinct from each American temperate-centered *Vernonia*, South American *Critoniopsis*, and Venezuelan *Tephrothamnus* Sch. Bip. The nine Central American species of *Eremosis* (basically those not treated by Turner 2007) are revised for Flora Mesoamericana project. Eleven new combinations are made for Mexican and Central American species, and the 27 recognized species of *Eremosis* (Table I places each species in one of nine somewhat arbitrarily defined informal species groups; viz similarly nearly throatless *E. leiocarpa* and *E. standleyi* being placed in different groups; as are T-shaped trichome-bearing *E. angusta* and *E. thomasii*) are enumerated with abbreviated typology and synonymy from among the suites of specimens mostly seen while working for about a decade each at NY, US, and MO.

Materials and Methods. Cypselae were boiled for one minute, dissected longitudinally into four pieces, and their ovaries and pappus removed. The pericarps were then bleached in a 5% aqueous hydrogen chloride solution for 20 minutes. Half of the pericarps were mounted on glass slides with their epidermis face-up and half were mounted with the epidermis face-down. Other preparations are basically those of Pruski (2012).

Non-glandular trichomes. Urbatsch (1972) and Faust and Jones (1973) reported both L-shaped and simple non-glandular trichomes in north temperate *Vernonia* Schreb. sensu stricto. Redonda-Martínez et al. (2012) showed that L-shaped, T-shaped, and simple non-glandular trichomes occur in Neotropical *Vernonanthura* H. Rob. And still elsewhere, another heterotrichous Vernonian group was noted by Wagner et al. (2014), who reported bladder-stellate, T-shaped, and simple non-glandular trichomes in Brazilian-centered Lychnophorinae. Andean *Critoniopsis* was also shown as very heterotrichous and was characterized in Haro-Carrión and Robinson (2008: Figs. 4–9) and Robinson and Keeley (2015: Fig. 3C; below viz also Fig. 4) by its "most often irregularly branched to stellate" non-glandular trichomes. Robinson (2009: Fig. 6:4) showed also goblet-shaped and basally-spurred non-glandular trichomes in *Critoniopsis*, T-shaped non-glandular trichomes in Venezuelan *Tephrothamnus paradoxus* Sch. Bip. (treated by Robinson 1993 in *Critoniopsis*), and simple trichomes in *E. leiocarpa*. Robinson (2009) suggested that by the presence of non-glandular trichome types *Tephrothamnus* and *Eremosis* could "be excluded" from Piptocarphinae. However, Haro-Carrión and Robinson (2008, Fig. 10A) also noted simple vermiform non-glandular trichomes in *C. suaveolens* (Kunth) H. Rob., and Robinson and Keeley (2015: Fig. 3F) noted T-shaped non-glandular trichomes in *C. glandulata* (Cuatr.) H. Rob. Apparently Piptocarphinae is not defined solely by kinds of trichomes as individual trichome types are known to co-occur in distinct subtribes.

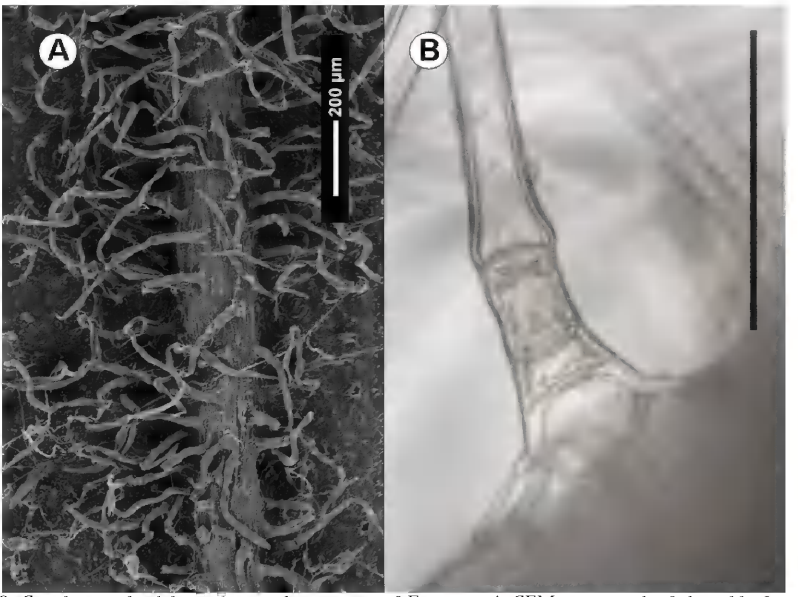

Figure 2. Simple non-glandular trichomes characteristic of *Eremosis*. A. SEM micrograph of abaxial leaf surface of *Eremosis mima*. B. LM photograph of multicellular base of simple non-glandular abaxial surface foliar trichome of *Eremosis leiocarpa*. The terminal cells are elongated. (A *Véliz 94.3535*, MO; B *Breedlove 50060*, MO). [Scale bar: B 0.1 mm].

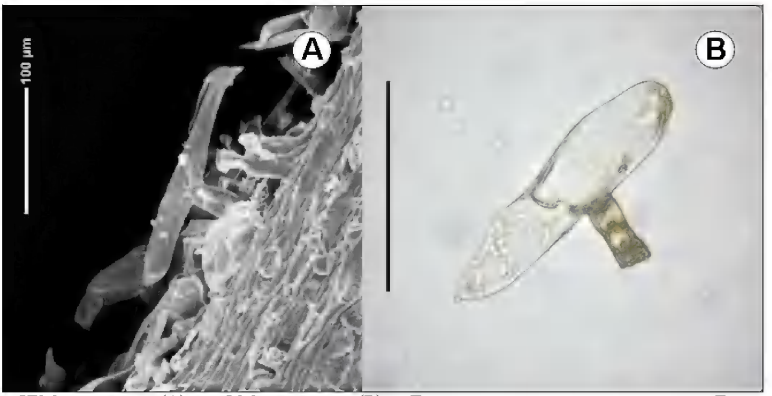

Figure 3. SEM micrograph (A) and LM photograph (B) of T-shaped non-glandular trichomes of *Eremosis thomasii*. Both from *Hawkins 988* (MO). [Scale bar: B 100 µm].

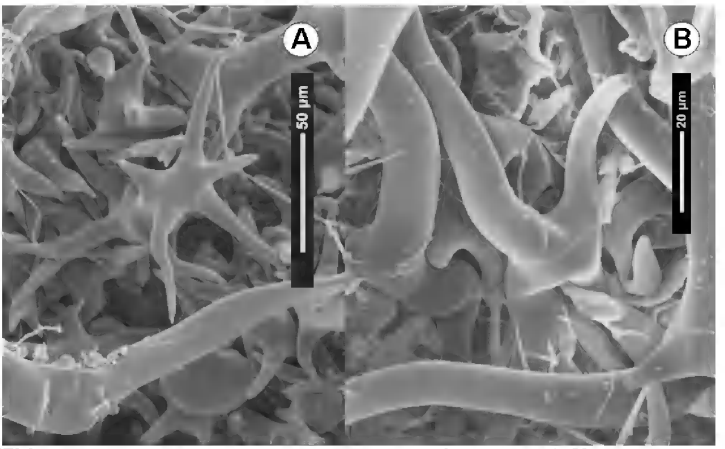

Figure 4. SEM micrographs of non-glandular foliar trichomes in *Critoniopsis*. A. Unicellular, bladder-stellate trichomes in *Critoniopsis oblongifolia* Sagást. & M.O. Dillon. B. Irregularly ramified trichomes in *Critoniopsis lindenii* Sch. Bip., the generitype. (A *Sagástegui et al. 15798*, MO, an isotype; B *Triana 91*, MO).

Eremosis typically bears only simple non-glandular trichomes (viz Fig. 2), although Jones (1973) also noted T-shaped non-glandular trichomes in *E. angusta*. T-shaped non-glandular trichomes have subsequently also been observed in Honduran *E. thomasii* (Fig. 3). The "bilobed" trichomes of Vernonieae referred to in *Eremosis* by Jones (1973: viz Table II) and illustrated by Urbatsch (1972: Fig. 3A), Faust and Jones (1973: Figs. 1A–B, 2A), Robinson (2009: Fig. 6:4D), and Redonda-Martínez et al. (2012: Figs. 1D, 1H), are sessile globular glandular trichomes and occur widely throughout the tribe. The mention by Favi et al. (2008) of "peltate-glands" in *Vernonia* is in reference instead to short-stipitate biseriate glands; *Vernonia* lacks true peltate trichomes. In *Eremosis*, the sessile globular glandular trichomes (when present) in each species appear to be morphologically similar and are not further considered. Presence of similar simple, T-shaped, bladder-stellate non-glandular trichomes in *Eremosis*, *Critoniopsis*, and Lychnophorinae represent three of many Vernonian

groups where vestiture features are not at all diagnostic at higher taxonomic levels. Nevertheless, at lower taxonomic levels non-glandular trichome compliments may be a useful character and indeed, *Critoniopsis* mostly has non-glandular trichomes variously branched or armed, and *Eremosis* mostly simple non-glandular trichomes. Here, light microscope (LM) photographs and scanning electron microscope (SEM) micrographs of representative simple and T-shaped non-glandular trichomes in *Eremosis* (Figs. 2–3) and representative armed non-glandular trichomes in *Critoniopsis* (Fig. 4) are given.

Cypselae. Cypselae of *Eremosis* are obconical-prismatic, have 3–10 indistinct to obvious angles, striations, or costae and sometimes moderately developed apical callose zones (Fig. 5). Although the character extremes in cypselae that range from weakly few-striate to thickly 10-costate are noteworthy, species at each extreme are retained in *Eremosis,* as in Gleason (1922) and Jones (1973). For example, the first key lead in Gleason (1922) separated from remaining species *E. heydeana* and *E. leiocarpa* by their glabrous abaxially smooth cypselae. The cypselae surfaces of *Eremosis* may be solely pubescent with non-glandular trichomes, solely glandular, both glandular and pubescent, or glabrous throughout (Fig. 5). Bulbous idioblast cells are frequently present in the pericarp wall. When pubescent, the cypselae of *Eremosis* differ from those of basically non-setiferous *Critoniopsis* (Fig. 6B; Robinson 1993: 607) and *Tephrothamnus*. Although most species of *Eremosis* have unevenly few-angled cypselae, the Mesoamerican endemic *E. shannonii* has evenly strongly pluricostate cypselae (as keyed by Jones 1973), yet it falls within each of our concepts of *Eremosis*.

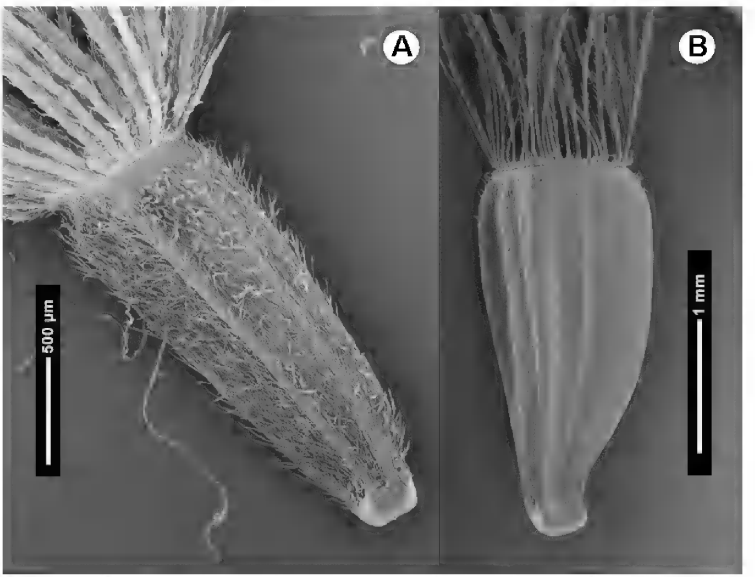

Figure 5. SEM micrographs of isomorphic simple pappus bristles and cypselae of *Eremosis*. A. *Eremosis thomasii*, showing the pilose, non-glandular, obviously costate cypselae with a glabrous slightly developed apical callose zone; most species of *Eremosis* have cypselae similarly setiferous. B. *Eremosis mima*, showing the basically glabrous cypselae with a narrow apical callose zone bearing narrow-based pappus bristles; the inner adaxial face (left) is weakly few-striate-costate and in mature cypselae the outer abaxial face (right) is more or less smooth and rounded. (A *Hawkins 884*, MO; B *Castillo & Vargas 2765*, MO).

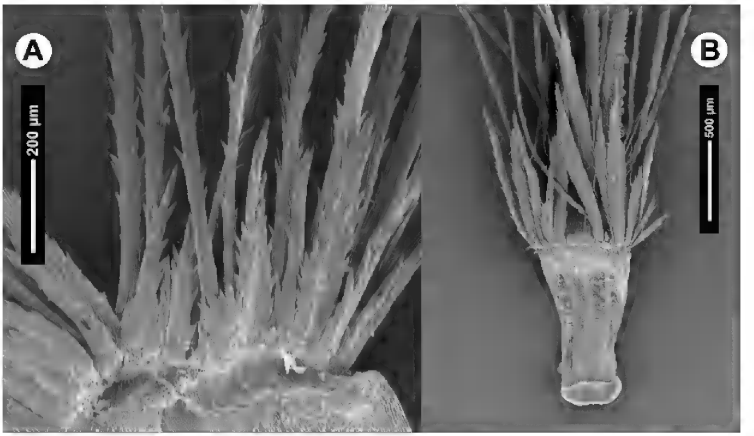

Figure 6. SEM micrographs of double pappus of short broad outer scales and elongate inner bristles that are characteristic of cypselae of *Critoniopsis*. A. *Critoniopsis lindenii* Sch. Bip., the generitype. B. *Critoniopsis oblongifolia* Sagást. & M.O. Dillon, showing the non-setiferous cypselae typical of *Critoniopsis*. (A *Triana 91*, MO; B *Sagástegui et al. 15798*, MO, an isotype).

Elsewhere in Vernonieae, Pruski (1996) noted similar cypsela variations in *Piptocoma* Cass. (Piptocarphinae), where he recognized four sections. Similarly, it seems possible that infragenera stressing cypsela morphologies, and in turn the association of glabrous cypselae with a narrow apical callose zone giving rise to relatively narrow elongate slightly non-contiguous basally pappus bristles (viz Fig. 5B), could ultimately be recognized within *Eremosis*. At present, *Eremosis* itself is not divided, and more than being a convenient species residuum, *Eremosis* seems to be a natural group as defined by Gleason (1906, 1922) and Jones (1973). However, Robinson (1999b) noted that in many species groups of *Gymnanthemum* Cass. (albeit with some later removed to *Decaneuropsis* H. Rob. & Skvarla 2007 and elsewhere) members may have cypselae 5-costate or 10-costate, possibly devaluing infragenerically this character when used within related genera. The apical callose zone in *Eremosis* is sometimes slightly pronounced, but it is often poorly developed in glabrous-fruited species. A very large inflated apical callose zone characterizes subtribe Leiboldiinae, and some species of *Eremosis* begin slightly to approach this condition more so than do most taxa now placed in either Piptocarphinae or Vernoniinae. The pappus of *Eremosis* may be in a single series or in 2 series, often with all bristles elongate. However, several species of *Eremosis* have a shorter outer series of bristles, but then these shorter bristles are always as narrow as the inner and never broad and scale-like (Fig. 5). It is the isomorphic diameter of the pappus bristles in *Eremosis* that perhaps further distinguishes it from *Critoniopsis*, which typically has a double pappus of outer short broad scales and inner elongate bristles (Fig. 6).

Pericarp Crystals (raphides). The pericarps in *Eremosis* when bleached are seen to be littered with calcium oxalate crystals (raphides), which are moderately elongate and hexagonal (e.g., Figs. 7–8). The pericarp raphide crystals seen in *Critoniopsis* (Fig. 9B) are quadrangular or hexagonal and moderately similar to *Eremosis*. Robinson (1999a: viz Table 7) noted only quadrangular crystals in *Critoniopsis*, so further study of variation in crystal shapes is needed. *Piptocarpha triflora* has quadrangular pericarp crystals (Fig. 9A), but Robinson (1999a) noted a range from quadrangular to hexagonal crystals in the genus. Angulo et al. (2015) showed pericarp crystals in species of *Lessingianthus* H. Rob. (Vernoniinae) range from quadrangular to elongate hexagonal, and it is possible that similar variability may be present in *Eremosis* and *Critoniopsis*. At present, it appears that

Eremosis may be distinguished provisionally from *Critoniopsis* by its trend (albeit perhaps not a statistically noteworthy one) towards elongate hexagonal pericarp crystals. Figure 10 and Robinson (1999a: Tables 2–6) show wide variation but an overall trend toward elongate crystals in many Vernoniinae as opposed to those observed in *Eremosis*. Angulo et al. (2015) concluded that crystal types "may not be useful for generic segregation." Here, the trend towards having moderately elongate hexagonal pericarp crystals seems best used in tandem with other features to characterize *Eremosis*.

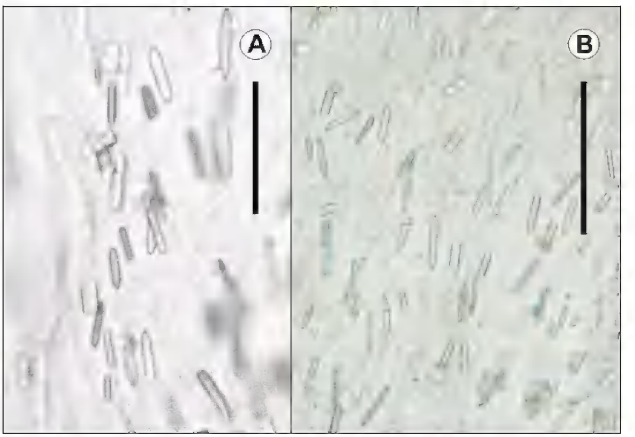

Figure 7. Moderately elongate hexagonal pericarp raphide crystals of *Eremosis corymbosa*. Both from *Pringle 6188* (MO), an isotype of synonymous *Eremosis leiophylla*. [Scale bars: A 30 µm; B 50 µm].

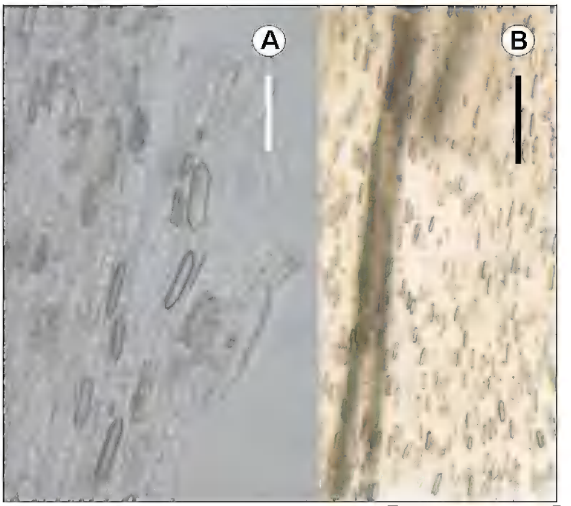

Figure 8. Moderately elongate hexagonal pericarp raphide crystals of *Eremosis leiocarpa*. Both from *Jones 21675* (MO). [Scale bars: A 50 µm; B 10 µm].

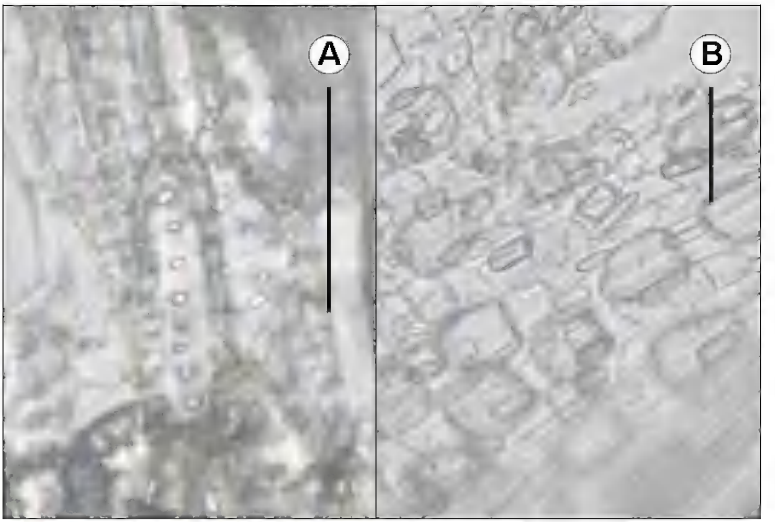

Figure 9. Pericarp raphide crystals in two representative Piptocarphinae. A. *Piptocarpha triflora*, crystals quadrangular. B. *Critoniopsis jelskii*, crystals quadrangular and hexagonal; several surface bulbous idioblast cells are present. (A *Pruski et al. 3456*, NY; B *Vásquez et al. 26186*, MO). [Scale bars: A 15 µm; B 10 µm].

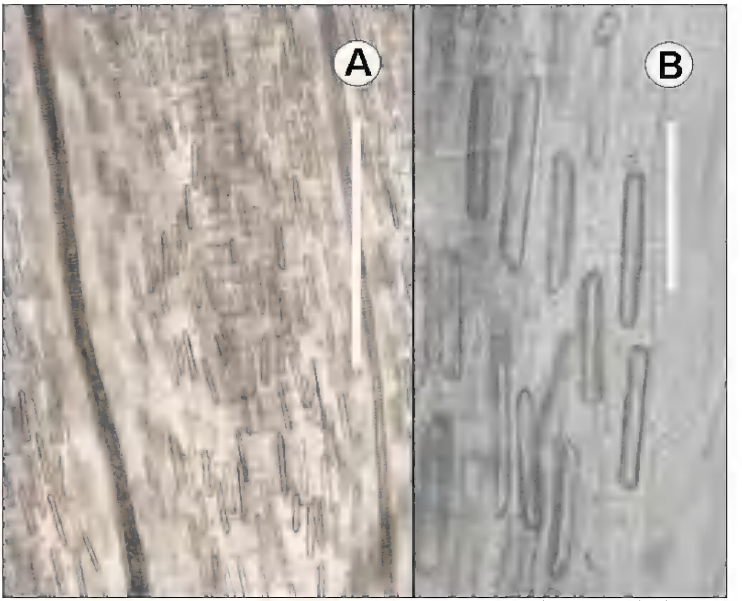

Figure 10. Elongate hexagonal pericarp raphide crystals of *Lepidaploa tortuosa* (Vernoniinae). (Both from *Pruski et al. 4239*, MO). [Scale bars: A 50 µm; B 10 µm].

EREMOSIS (DC.) Gleason, Bull. New York Bot. Gard. 4: 227. 1906. *Monosis* sect. *Eremosis* DC., Prodr. 5: 77. 1836. *Vernonia* sect. *Eremosis* (DC.) Sch. Bip., Linnaea 20: 506. 1847; Sch. Bip. in Seemann, Bot. Voy. Herald 297. 1856; Benth. & Hook. f., Gen. Pl. 2: 231. 1873. *Vernonia* subsect. *Eremosis* (DC.) S.B. Jones, Rhodora 81: 435. 1979. **LECTOTYPE** (Gleason 1906: 227): *Monosis salicifolia* DC. [= *Eremosis corymbosa* (Mill.) Pruski].

Turpinia Lex., Nov. Veg. Descr. 1: 24. 1824 (non *Turpinia* Vent., July 1807, Staphyleaceae, nom. cons.; non *Turpinia* Pers., April 1807, Fabaceae; non *Turpinia* Bonpl., April–June 1807, Barnadesieae). **TYPE**: *Turpinia tomentosa* Lex. [≡ *Eremosis tomentosa* (Lex.) Gleason].

Figure 11. Lectotype (*Houstoun s.n.*, BM) of uniflorous *Conyza corymbosa* Mill. [≡ *Eremosis corymbosa* (Mill.) Pruski, which includes in synonymy *Monosis salicifolia* DC., the type of *Eremosis*].

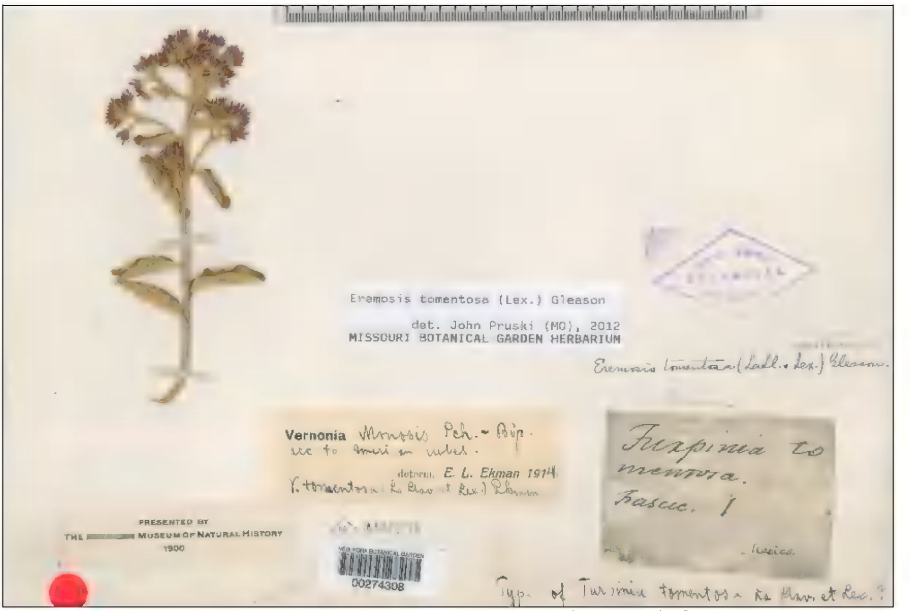

Figure 12. Historical specimen of uniflorous *Turpinia tomentosa* Lex. (*Anon.*, NY). [≡ *Eremosis tomentosa* (Lex.) Gleason], a name published in Nov. Veg. Descr. fascicle 1. *Turpinia tomentosa* is the generitype of *Turpinia* Lex., a synonym of *Eremosis*. Although this specimen is labeled as "Fascic. 1" and the handwriting on the rectangular label is of the Spanish School, I am uncertain if it was written by Lexarza. Perhaps instead it was written by La Llave, Sessé and Mociño (although not on longitudinally elongated labels), etc. This top-snatch specimen, although only a possibly authentic isotype is, nevertheless, used to confirm *Turpinia* as a generic synonym of *Eremosis*. A 15 cm ruler is at top.

Shrubs, vines, or trees to 15+ m, rarely collected flowering when seemingly a perennial herb; stems subterete to striate, sometimes angled; herbage usually with simple (infrequently T-shaped, seen only in *E. angusta* and *E. thomasii*) non-glandular trichomes, these never lepidote nor bladder-stellate. **Leaves** alternate, petiolate or rarely sessile; blade lanceolate to ovate or obovate, chartaceous to subcoriaceous, pinnately veined, surfaces (even the adaxial) pubescent to tomentose, often glandular, infrequently completely glabrous, margins entire to serrulate or denticulate. **Capitulescence** terminal (infrequently axillary), of many rounded corymbiform or umbellate, pluricephalous clusters forming a large compound panicle (viz Jones 1973: Figs. 1B, 1D), ultimate capitula sometimes subglomerate. **Capitula** discoid, 1–10(–16)-flowered, usually subsessile or short-pedunculate; involucre cylindrical to campanulate; phyllaries imbricate, graduate, 4–7+-seriate, usually tan-chartaceous often with a small apical herbaceous zone, outer phyllaries often closely inserted and densely imbricate, persistent, inner phyllaries somewhat loosely imbricate and moderately deciduous although sometimes only tardily so; clinanthium epaleate. **Florets**: corolla actinomorphic, funnelform to narrowly campanulate, infrequently salverform, 5-lobed, white to lavender, often glandular especially on the lobes; anther thecae sagittate to obtuse at base, without sclerified tails, apical appendage cell walls moderately thick; pollen tricolporate, echinate, sublophate (Type A; viz Jones 1979a: Fig 4A; Keeley and Turner 1990: Table 2); style with slightly enlarged basal node, trunk papillose distally, branches slender, sweeping papillae acute to obtuse (never blunt) at apex. **Cypselae** obconical-prismatic, 3–10-angled, 3–10-striate, or 3–10-costate, glabrous, glandular, or pubescent, apical callose zone slightly developed, rarely elongated as a membranous

skirt exterior to pappus bristles, apex truncate, base narrowed, pericarp with crystals moderately elongate hexagonal, carpopodium without distinct upper rim; pappus of many fragile white scabrid bristles, simple, uniseriate and typically most elongate (with innermost the longest) or sometimes with a distinct outer series of narrow bristles that are never broadened and scale-like. $x = 17, 18, 19$.

Eremosis is a Mexican and Central American genus of 27 recognized species (Table I), and is recognized as distinct from each *Critoniopsis* and *Vernonia*. *Vernonia duncanii, V. macphersonii,* and *V. salicifolia/uniflora*, each recognized by either Jones (1973) or Turner (2007), are treated here in synonymy; if shown to be distinct recognition of them could raise to 30 the number of species of *Eremosis*. Salient features of *Eremosis* are its woody habit, usually simple non-glandular trichomes, large and compound paniculate capitulescences, few-flowered capitula, deciduous inner phyllaries, relatively long, acute to obtuse-tipped style branch sweeping papillae, cypselae usually setiferous and with a slightly developed apical callose zone, an isomorphic pappus of relatively narrow-based bristles, and a slight trend towards moderately elongate hexagonal pericarp raphide crystals. The base chromosome numbers of *Eremosis* appear to be $x = 17, 18, 19$ (Jones 1973, 1979b), and the base numbers of "10, 17?" given for "*Vernonia* subsect. *Eremosis*" by Keeley and Turner (1990) seems aberrant. Robinson (1999a) gave as $x = 17$ the base number of *Critoniopsis* (then including *Eremosis*). Jones (1973) reported chromosome numbers of only five uniflorous species: *E. aristifera, E. leiocarpa*, and *E. obtusa* as diploids; and *E. corymbosa* and *E. tomentosa* as tetraploids. *Eremosis* was treated as a member of subtribe Vernoniinae by Robinson et al. (1980), in synonymy of *Critoniopsis* (subtribe Piptocarphinae) by Robinson (1993, 1999a), who stressed the character of deciduous inner phyllaries, and as unplaced to subtribe by Keeley and Robinson (2009). Although Robinson (1999b) noted that both American Piptocarphinae and Paleotropical Gymnantheminae share the character of deciduous inner phyllaries, this nevertheless remains a convenient character for recognizing *Eremosis*. Jones (1973), Harborne and Williams (1977), Jones (1979a), Seaman (1982), and Bohlmann and Jakupovic (1990) gave the secondary metabolite sesquiterpene lactone class glaucolide as found in species treated here as *Eremosis*, but they also noted that glaucolides are widespread in each Leiboldiinae, Piptocarphinae, and Vernoniinae. Another feature noted by Jones (1979a) as characteristic of *Eremosis* is the tricolporate echinate sublophate (Type A) pollen, also widespread elsewhere in Vernonieae. *Eremosis* is sister to Leiboldiinae but remains unplaced subtribally. Further study of phyllary persistence, cytology, glaucolide types, and pollen features, however, may help resolve ultimate placement of these taxa.

With regards to *Eremosis* species in Central American, it may be useful to note that Nash (1976) treated as Guatemalan seven of the nine species treated here in Mesoamerica, and only *E. oolepis* and *E. thomasii* remain unreported in Guatemala. The report by Sousa and Cabrera (1983: 81) of *E. barbinervis* (Sch. Bip.) H. Rob. in Quintana Roo is based on a misdetermination of *E. oolepis*. Breedlove (1986) cited *E. pallens* (Sch. Bip.) H. Rob. for Chiapas based on *Breedlove 24648* and *Ton 2073*. Turner (2007), however, listed this species as occurring only far to the NW of Chiapas, and pauciflorous *Breedlove 24648* is determined here as *E. triflosculosa*. Thus, each *E. barbinervis* and *E. pallens* are excluded from Mesoamerica. The citation by Turner (2007: 133) of *E. triflosculosa* in Quintana Roo, Mexico, is also presumably based on material of *E. oolepis*. *Vernonia mima* by its glabrous cypselae similar to *E. shannonii* is aligned with *Eremosis* and is one of six species endemic to Mesoamerica.

Of the six Mesoamerican endemics, only *E. standleyi* is moderately common; it can be distinguished by its long-lobed nearly throatless corollas (Fig. 14) and pilose-sericeous fruits. Five of nine Flora area species have been collected at or below 600 meters elevation (elevations here are rounded to nearest 100 meter intervals), but in general *Eremosis* is mid-elevational. *Eremosis heydeana*, described from Guatemala, is relatively widespread and occurs northwards into central Mexico but is nowhere common. On the other hand, *E. leiocarpa* and *E. triflosculosa* are widespread

and moderately common throughout much of southern Mexico and Central America. *Eremosis leiocarpa* and *E. triflosculosa* are often similarly tomentose-leaved and are best distinguished by corolla throat-lobe and fruit indumentum characters.

Seven of nine (78%) Mesoamerican species and four of six (67%) of Mesoamerican endemic species follow species key lead 1A or 6B; and in Table I fall into either the first or last morphologically-defined species group. Overall, only 11 of 27 (41%) species fall into either the first or last species group, showing a relative concentration of a few morphotypes (as delineated here in Table I) in Mesoamerica. On the other hand, only two of 27 species of *Eremosis*, each a Mesoamerican endemic (i.e., *E. angusta* and *E. thomasii*), are reported to have T-shaped non-glandular trichomes. Eleven of the total 27 (41%) species are primarily uniflorous and spread among species groups 2–5, but in Mesoamerica only *E. angusta* (one of nine species, 11%) is uniflorous. Should each of the following problem synonyms of uniflorous species [i.e., *V. duncanii* group two, *V. macphersonii* group four, and *V. uniflora* group five, viz Table I] be resurrected, the genus would expand to include 30 species; only 33% would then fall into either species group one or species group nine; and the count of primarily uniflorous species would increase from eleven (41%) to fourteen (47%).

Eremosis was recognized at the genus level by Gleason (1906, 1922), and Jones (1973) revised it recognizing 20 species. Robinson (1993) transferred most Mexican and Central American species to *Critoniopsis*. In the Flora del Bajio Rzedowski and Calderón de Rzedowski (1995a) treated six species of *Eremosis* as *Vernonia*, giving the names in *Eremosis* as synonyms, but not listing the then recently published (Robinson 1993) names in *Critoniopsis*. Turner (2007) revised Mexican *Eremosis* species also under the name *Vernonia*, and he updated Jones (1973) by including treatments of the species described after the Jones monograph. Redonda-Martínez and Villaseñor-Ríos (2009), Carnevali et al. (2010), and Villaseñor-Ríos (2011) recognized as *Critoniopsis* species of *Eremosis* in Flora del Valle de Tehuacán-Cuicatlán, the Yucatán peninsula, and Oaxaca, respectively. Berendsohn et al. (2009) treated as *Critoniopsis* three species of *Eremosis* in El Salvador.

For the present Flora Mesoamericana project treatment of *Eremosis*, I use a combination (nearly chronologically) of the taxonomies of Gleason (1906, 1922), Blake (1917), Blake et al. (1926), Jones (1973), Robinson (1993), and Turner (2007). The taxonomies of *E. obtusa*, *E. foliosa*, and *E. steetzii* groups, as noted by Blake et al. (1926) and McVaugh (1972a), are not satisfactorily worked out. Although Jones (1973) recognized *V. salicifolia* and *V. uniflora* as distinct, they are provisionally treated here in synonymy with *E. corymbosa*. Elsewhere too, the present treatment is conservative with broad species limits allowed; for example, six names previously proposed in *Eremosis* are treated in synonymy, and *V. duncanii* and *V. macphersonii* are not transferred to *Eremosis* but rather treated here in synonymy.

Following the Central American species treatments, the recognized species in *Eremosis* are briefly enumerated with new nomenclatural combinations made for eight Mexican endemics. I hope this abbreviated summary will supplement the fine revision of Jones (1973) and the thorough nomenclator of American Vernonieae in Robinson (1999a). In the discussion above and in what follow, species are generally referred to as *Eremosis* even though called *Vernonia* in Jones (1973) and Turner (2007) and even though 11 names in *Eremosis* have not been coined before today. Several names in *Vernonia* prove to be synonyms of *Eremosis* species, and those never treated nomenclaturally as *Eremosis* are still called *Vernonia* herein.

Key to Mesoamerican species of *Eremosis*

1. Cypselae glabrous or when sparsely glandular then either only distally so or with involucres 10–13 mm long.

2. Corollas nearly throatless with lobes cut to near tube; leaf blades discolorous, usually densely tomentose abaxially; mid-series phyllary apices usually broadly obtuse and tomentulose. ..... **3. Eremosis leiocarpa**
2. Corollas with throat, lobes not cut to near tube; leaf blades more or less concolorous, glabrate to sparsely tomentulose abaxially; mid-series phyllary apices either acute or non-tomentose.

3. Capitula ca. 10-flowered. ..... **4. Eremosis mima**
3. Capitula 3–6(–7)-flowered.

4. Leaf blades pilose-hirsute to sometimes sparsely tomentulose; cypselae unequally 3–4-costate-angled with abaxial face often smooth and rounded, ca. 3 mm long; involucres 4–6 mm long; corollas glandular in distal half, tube infrequently glandular. ..... **2. Eremosis heydeana**
4. Leaf blades closely arachnoid-pubescent becoming glabrate; cypselae sometimes equally 10-costate, terete, 4–6.5 mm long; involucres 10–13 mm long; corollas glandular almost throughout. ..... **6. Eremosis shannonii**

1. Cypselae pubescent, sometimes also glandular; involucres 4–6.5 mm long.

5. Capitula 1-flowered; abaxial leaf surfaces tomentulose with T-shaped non-glandular trichomes. ..... **1. Eremosis angusta**
5. Capitula 3–10-flowered; abaxial leaf surfaces (when pubescent) typically with simple non-glandular trichomes.

6. Capitulescences of axillary glomerules, glomerules usually sessile; corolla lobes about half the length of corollas, cut nearly to base of limb, throat nearly lacking. ..... **7. Eremosis standleyi**
6. Capitulescences variously paniculate, terminal or sometimes lateral; corolla lobes usually 1/3–1/4 length of corollas, throat present.

7. Capitulescences cylindrical-paniculate, mostly on lateral branchlets along length of stems. ..... **5. Eremosis oolepis**
7. Capitulescences rounded-paniculate or pyramidal-paniculate, terminal.

8. Non-glandular stem trichomes T-shaped; involucres narrowly campanulate, 2.5–3 mm diam. ..... **8. Eremosis thomasii**
8. Non-glandular stem trichomes simple; involucres cylindrical, 1.3–2.5 mm diam. ..... **9. Eremosis trifloscul**osa

1. EREMOSIS ANGUSTA Gleason, N. Amer. Fl. 33: 98. 1922. **TYPE: GUATEMALA. Zacapa.** Gualan, 125 m, 21 Feb 1907, *Kellerman 6132* (holotype: F).

Critoniopsis angusta (Gleason) H. Rob., *Vernonia angusta* (Gleason) Standl.

Shrubs or small trees to 5 m tall; stems tomentulose. **Leaves** petiolate; blade 5–19(–6) × 1.5–2(–3) cm, lanceolate to elliptic-lanceolate, usually widest above the middle, 2° veins usually 5 per side, adaxial surface scabrous, abaxial surface sparsely tomentulose with T-shaped (dolabriform)

non-glandular trichomes, also glandular, base cuneate, margins entire, revolute, apex acute to acuminate; petiole 0.5–1 cm long. **Capitulescences** ca. 10 cm diam., densely subglomerate-paniculate, rounded, terminal from distal-most nodes, capitula subsessile to short-pedunculate. **Capitula** 1-flowered; involucre 6–8 × ca. 1.5 mm, narrowly cylindrical; phyllaries ca. 6-seriate, sparsely tomentulose, apical mucro to ca. 0.5 mm long; outer phyllaries ca. 1.7 × ca. 1.1 mm, broadly ovate, apex obtuse; inner phyllaries 5.5–8 × ≤ 1 mm, oblanceolate, apex acute. **Florets**: corolla ca. 6.6 mm long, white. **Cypselae** 2–2.5 mm long, weakly costate, pilose-hirsute, non-glandular; pappus inner bristles ca. 6 mm long.

Distribution and Ecology. The rare Guatemalan endemic *E. angusta* flowers in February and March and has been collected between 100–1100 meters elevation.

Representative collection. **GUATEMALA.** *Kellerman 7922* (F).

Jones (1973) noted the presence of T-shaped non-glandular trichomes in *E. angusta*. I have not seen any specimens collected in the past century.

2. **EREMOSIS HEYDEANA** (J.M. Coult.) Gleason, Bull. New York Bot. Gard. 4: 234. 1906. *Vernonia heydeana* J.M. Coult., Bot. Gaz. 20: 4. 1895. **TYPE: GUATEMALA. Quiché.** San Miguel Uspantán, 6000–12000 ft., Apr 1892, *Heyde & Lux 3392* (holotype: F; isotypes: GH, K, US).

Critoniopsis heydeana (J.M. Coult.) H. Rob.

Shrubs to trees to 8–15+ m tall; stems sometimes vining, finely tomentulose to hirsutulous, later glabrate. **Leaves** petiolate; blade 4–10(–14) × 2.8–6(–7.5) cm, usually ovate and widest at or below the middle, 2° veins usually 5–7 per side, adaxial surface hirsutulous to glabrate, sometimes glandular, abaxial surface pilose-hirsute to sometimes sparsely tomentulose, pubescent with simple non-glandular trichomes, also glandular, base cuneate or obtuse, margins entire to remotely denticulate, apex acute to acuminate; petiole 0.9–2 cm long. **Capitulescences** 10–15 cm diam., loosely subglomerate-paniculate, rounded to long-pyramidal, terminal from distal-most nodes, capitula subsessile to distinctly short-pedunculate. **Capitula** 3–6-flowered; involucre 4–6 × 3–4 mm, campanulate, on bracteolate stipe; phyllaries 5–7-seriate; outer phyllaries many, 1–1.5 × 0.4–0.6 mm, triangular, sparsely tomentulose, apex usually narrowly acute; mid-series phyllary apices usually acute and subglabrous; inner phyllaries 4–6 × 0.8–1.1 mm, oblanceolate, subglabrous, apex obtuse. **Florets**: corolla 5.2–6.3 mm long, usually glandular mostly in distal half, tube infrequently glandular, throat present, lobes 1.4–2 mm long, about twice as long as throat, only ca. 1/3 length of corolla. **Cypselae** ca. 3 mm long, unequally 3–4-costate-angled, glabrous or sometimes sparsely glandular distally, never densely setiferous; pappus somewhat biseriate, outer bristles few, to ca. 1 mm long, inner bristles 5–6 mm long.

Distribution and Ecology. *Eremosis heydeana* is known from oak forests and selva caducifolia in Guatemala and Mexico (Chiapas, Jalisco, ?Oaxaca, Puebla, Querétaro, San Luis Potosí, Veracruz). It has been collected from about 900–1800 meters elevation and flowers from January to April. Jones (1973) cited *E. heydeana* in Mexico only in Veracruz, but Rzedowski and Calderón de Rzedowski (1995a) listed it for several other states on the Gulf watershed. In Querétaro *E. heydeana* occurs only at the extreme eastern frontier near the border with Hidalgo and San Luis Potosí. It is expected in Hidalgo and adjacent areas. Turner (2007) gave *E. heydeana* as expected in Oaxaca.

Representative collections. **GUATEMALA**. *Heyde & Lux 3392* (F, GH, K, US; the type). **MEXICO. Chiapas.** *Breedlove 32777* (CAS, LL, MO); *García et al. 1448* (CICY, MEXU, MO). **Querétaro.** *Rzedowski 42820* (ENCB, IEB). **Veracruz.** *Smith 1845* (F); *Ventura 16930* (MO); *Ventura 16968* (MO).

The widespread but moderately uncommon *E. heydeana* may generally be distinguished from *E. leiocarpa* by its leaf blades abaxially less pubescent, but occasionally when this character begins to fail (e.g., *Breedlove 32777*) the narrower subglabrous mid-series phyllaries of the longer pedunculate capitula help to distinguish it from the much more common discolorous-leaved *E. leiocarpa*. *Eremosis heydeana, E. shannonii,* and *E. triflosculosa* have on occasion been collected as large-trunked 10+ meter tall trees; perhaps at least *E. heydeana* and *E. shannonii* are under-collected and more common than may be inferred from material poorly represented in herbaria.

3. EREMOSIS LEIOCARPA (DC.) Gleason, Bull. New York Bot. Gard. 4: 232. 1906. *Vernonia leiocarpa* DC., Prodr. 5: 34. 1836. **TYPE: MEXICO**. sin. loc., 1827–1832, *Karwinski s.n.* (holotype: M; isotype: G-DC, as IDC microfiche 800 769.I.4). Figures 2B, 8.

Cacalia leiocarpa (DC.) Kuntze, *Critoniopsis leiocarpa* (DC.) H. Rob., *Eremosis melanocarpa* Gleason, *Vernonia melanocarpa* (Gleason) S.F. Blake

Shrubs or trees 1–5+ m tall, crowns dense and rounded; stems densely tomentose to proximally glabrate. **Leaves** petiolate; blade 6–14(–18) × 2–9 cm, elliptic-ovate to ovate, usually widest below the middle, 2° veins usually 5–8 per side, adaxial surface villous-pilose or sparsely tomentulose to glabrate, abaxial surface usually densely tomentose, pubescent with simple non-glandular trichomes, base cuneate to obtuse or sometimes rounded, margins entire to obviously denticulate, apex acute to acuminate; petiole 1–3 cm long. **Capitulescences** 5–23 cm diam., densely subglomerate-paniculate, pyramidal, terminal from distal-most nodes, main lateral branches usually longer than subtending leaves, capitula subsessile to short-pedunculate. **Capitula** 3–5(–7)-flowered; involucre 3.5–7 × 2.2–3 mm, narrowly campanulate; phyllaries 5–6-seriate, sometimes in distinct vertical ranks, distally tomentose to tomentulose; outer phyllaries 1.3–2.2 × 1–1.9 mm, broadly triangular, apex broadly obtuse; mid-series phyllary apices usually broadly obtuse and tomentulose; inner phyllaries 3.5–6 × 1–1.9 mm, oblanceolate, subglabrous, apex obtuse or sometimes acute. **Florets:** corolla 6–6.7 mm long, white to pink, lobes sometimes distally glandular or setulose, throat nearly lacking, lobes cut to near tube, nearly 1/2 length of corolla, with the anthers thereby basically fully exserted and full exposed. **Cypselae** 2.5–3.2 mm long, broadly obconic-prismatic, unequally 3-costate-angled, glabrous, never densely setiferous, non-glandular, apical callose zone narrow; pappus bristles 1-seriate, all bristles seemingly elongate without a hint of a shorter outer series, 5–6.5 mm long. $2n = 34$ or 36 (Jones 1973).

Distribution and Ecology. *Eremosis leiocarpa* is widespread from southern Mexico (Chiapas, Guerrero, Oaxaca, Veracruz) southeastwards into Nicaragua where it occurs in open hills, pine forests, pine-oak forests, quebradas secas, rocky hillsides, selva caducifolia, selva perennifolia, and thickets. In Central America *E. leiocarpa* has been collected from about 600–2500 meters elevation and in flower from October to August, with an apparent peak from November to June.

Representative collections. **BELIZE**. *Hicks 65* (MO). **EL SALVADOR**. *Martínez 660* (B, LAGU, MO); *Standley 20372* (GH, NY, US); *Standley 21598* (NY); *Williams 9* (B, K, LAGU, MO). **GUATEMALA**. *Heyde & Lux 3416* (F, GH, MO, NY, US; type of synonymous *Vernonia melanocarpa*); *King 7302* (MO, NY, US); *Standley 61234* (F, GH); *Standley 83233* (F); *Türckheim II 1660* (MO); *Williams & Molina 15408* (MO). **HONDURAS**. *Clewell 3771* (MO, NY); *Croat & Hannon 63927* (K, MEXU, MO, NO, NY); *Keeley & Keeley 4039* (MO); *Molina 23390* (NY); *Nelson et al. 4058* (MO); *Williams & Molina 12226* (MO). **MEXICO. Chiapas**. *Breedlove 33434* (CAS, LL, MO, NY); *Breedlove 50060* (CAS, MO); *Breedlove 50280* (CAS, MO, NY, TEX); *Breedlove 50799* (CAS, MO, TEX); *Jones & Jones 21675* (GA, MO, TEX); *Martínez et al. 22456* (MEXU, MO, XAL); *Matuda 2776* (MO). **Guerrero**. *Rzedowski 27052* (MICH, MO). **Oaxaca**. *Camp 2481* (NY, US); *Jones & Jones 21666* (GA, MO, NY); *Liebmann 8548* (C, MO); *Mexia 9119*

(MO, NY). **Veracruz**. *Purpus 14068* (F, US). **NICARAGUA**. *Davidse et al. 30441* (MO); *Moreno 23515* (MO); *Standley 9604* (F); *Stevens et al. 29390* (MO).

Figure 13. Representative specimen of *Eremosis mima* (*Véliz 94.3535*, MO).

The common *E. leiocarpa* is the most consistently discolorous broad-leaved species in Central America. A drawing of *E. leiocarpa* was given in Monro et al. (2001: 35, left), but there the non-glandular leaf trichomes were I believe incorrectly depicted as stellate. *Eremosis leiocarpa* is similar in gestalt to *E. triflosculosa*, which differs by its often narrower, less pubescent leaves, narrower involucres, and pubescent fruits. Jones (1973: 91) noted glaucolide F and G in *E. leiocarpa*.

4. EREMOSIS MIMA (Standl. & Steyerm.) Pruski, **comb. nov.** *Vernonia mima* Standl. & Steyerm., Publ. Field Mus. Nat. Hist., Bot. Ser. 23: 264. 1947. **TYPE: GUATEMALA. Huehuetenango**. East of San Rafael Pétzal, 1730 m, 9 Jan 1941, *Standley 82871* (holotype: F; isotype: GH). Figures 2A, 5B, 13.

Shrubs 2–4 m tall; stems subscandent, striate, tomentulose to villosulous. **Leaves** petiolate; blade 5–12.5 × 3–8 cm, ovate or elliptic-ovate, widest at or below the middle, 2° veins 5–8 per side, adaxial surface sparsely puberulent to hirtellous or glabrate, abaxial surface tomentulose to villous, pubescent with simple non-glandular trichomes, base obtuse or rounded, sometimes with short-decurrent acumen, margins subentire, apex acute; petiole 1–3 cm long. **Capitulescences** in distal 20–30 cm of larger stems, corymbiform-paniculate or subumbellate, of several broadly rounded somewhat congested clusters 5–10 cm diam. on lateral branches (3–)7–15 cm long from distal 3–7 nodes, lateral branching at about 45–80° from larger stems; peduncles 2–6 mm long, tomentulose to villosulous, capitula infrequently subsessile. **Capitula** 10–13 mm long, ca. 10-flowered; involucre 8–9 × 4–5 mm, turbinate-campanulate; phyllaries 5–6-seriate, ascending, sometimes the outer slightly decurrent onto peduncle, pale-greenish, margins sometimes ciliate-villous; outer phyllaries 0.1–2 × 0.5–1 mm, triangular-lanceolate, villosulous, apex acute or acuminate; inner phyllaries 7–9 × 1–1.4 mm, about as high as pappus, lanceolate, distally slightly spreading and ultimately deciduous, subglabrous or sometimes villosulous, apex acute or sometimes obtuse. **Florets**: corolla 7–8 mm long, ochroleucous, glandular, tube ca. 5 mm long, longer than the limb, slender, throat campanulate, lobes 1.5–2.5 mm long, longer than throat, ca. 1/3 length of corollas. **Cypselae** 2.3–2.9 mm long, turbinate, unequally 3–4-costate-angled adaxially, abaxial (outer) face more or less rounded and smooth, glabrous, never densely setiferous, non-glandular, apical callose short or when mature with a well-developed (albeit perhaps simply unobstructed by setae and thereby more readily visible than in species with sericeous cypselae) bulbous subapical sclerified zone to 0.2+ mm long; pappus bristles 4.5–6 mm long, 1–2-seriate, sometimes when 1-seriate slightly non-contiguous at base.

Distribution and Ecology. *Eremosis mima* is endemic to Guatemala, where it occurs in Oak forests, thickets and on volcano slopes from about 1700–2100 meters elevation and flowers from January to March.

Representative collections. **GUATEMALA**. *Castillo & Vargas 2765* (MO, NY); *Steyermark 33990* (F); *Véliz 94.3535* (BIGU, MO); *Véliz 99.6954* (BIGU, MO); *Véliz 99.6984* (BIGU, MO).

Eremosis mima, endemic to (southwestern) Guatemala, by its leaves abaxially tomentulose and by cypselae glabrous and unequally 3–4-costate-angled is similar to *E. heydeana*, which was also described from Guatemala. *Eremosis mima* is distinguished *E. heydeana*, however, by ca. 10 (vs. 3–6) -flowered capitula and by villosulous (vs. glabrous) involucres that are 7–9 (vs. 4–6) mm long. In the protologue Standley and Steyermark (1947) noted its similarity to the common *E. leiocarpa*, but that generally *Eremosis* was 1–6-flowered. The very pubescent-leaved *E. mima* is in cypselae characters nevertheless also similar to weakly pubescent leaved *E. shannonii*.

5. EREMOSIS OOLEPIS (S.F. Blake) Gleason, N. Amer. Fl. 33: 97. 1922. *Vernonia oolepis* S.F. Blake, Contr. Gray Herb. 52: 20. 1917. **TYPE: MEXICO. Yucatán.** Izamal, 1888, *Gaumer s.n.* (holotype: GH; isotype: F).

Critoniopsis oolepis (S.F. Blake) H. Rob.

Vining shrubs to 3+ m tall; stems densely and finely tomentulose, sometimes glabrate proximally. **Leaves** petiolate; blade 6–10 × 2–5 cm, elliptic-ovate, widest at the middle, 2° veins usually 5–7 per side, surfaces nearly concolorous, adaxial surface glabrous, non-glandular, abaxial surface tomentulose, pubescent with simple non-glandular trichomes, also glandular, base cuneate, margins entire, subrevolute, apex acuminate; petiole 0.2–0.5 cm long. **Capitulescences** to ca. 40 cm long, cylindrical-paniculate, mostly terminating lateral branchlets 5–15 cm long that are found along length of elongate vining main stems, each lateral branchlet rounded apically with several 3–8-capitulate glomerules, these lateral flowering branchlets about 1.5× as long as subtending leaves, capitula subsessile; peduncles 0–1(–2) mm long. **Capitula** 3–5-flowered; involucre 5–6 × 2–3 mm, narrowly campanulate; phyllaries 5–7-seriate, arachnoid-ciliate; outer phyllaries 1–1.8 × 0.7–1.1 mm, triangular-ovate, apex broadly acute; inner phyllaries 5–6.5 × 1–1.4 mm, oblong, apex obtuse. **Florets**: corolla 5.5–7 mm long, glabrous, lobes ca. 1.5 mm long, ca. 1/3 length of corolla. **Cypselae** 1.5–3 mm long, 6–7-costate, the 3 abaxial costae prominent, setulose-substrigillose throughout with the subappressed setae at apex typically longer than and somewhat obscuring the very small glabrous apical callose zone, in the few collections seen the callose zone not bulbous-inflated; pappus 2-seriate, somewhat double, a few outer bristles usually distinctly shorter usually 1–2 mm long, inner bristles 5–6 mm long.

Distribution and Ecology. *Eremosis oolepis* is endemic to the Yucatán Peninsula (Campeche, Quintana Roo, and Yucatán), Mexico occurring in dry bush lands and selva subperennifolia from near sea level to 100 meters elevation, and flowering from December to April.

Representative collections. **MEXICO. Campeche.** *Chan 2009* (CICY). **Quintana Roo**. March 1917, *Gaumer 23648* (F, MO, NY, US); *Ucán & Poot 5102* (CICY, MO). **Yucatán.** *Carnevali & Tapia 6576* (CICY, MO); *Gaumer 23629* (F, K).

Jones (1973) gave the corollas as about "13 mm" long. Turner (2007) noted that *E. triflosculosa* is very similar to *E. oolepis*, which supposedly differs by corollas longer than 10 mm. The material of *E. oolepis* in my hands has corollas ≤ 7 mm long.

6. EREMOSIS SHANNONII (J.M. Coult.) Gleason, Bull. New York Bot. Gard. 4: 234. 1906. *Vernonia shannonii* J.M. Coult., *Bot. Gaz.* 20: 42. 1895. **TYPE: GUATEMALA. San Marcos.** continental divide, 9191 ft., Jan 1892, *Shannon 605* (holotype: US). As noted in the protologue, the type "material is very scanty."

Critoniopsis shannonii (J.M. Coult.) H. Rob.

Shrubs to trees 3–10 m tall; stems sparse tomentulose to glabrate. **Leaves** petiolate; blade (7–)10–17 × (2.5–)4–7 cm, usually elliptic-ovate, usually widest at the middle, 2° veins usually 7–9 per side (perhaps especially visible due to weak surface indumentum), surfaces non-glandular, glabrous or arachnoid-tomentulose with simple non-glandular trichomes, base cuneate to acuminate, margins entire, apex acute to acuminate; petiole 0.5–2 cm long. **Capitulescences** 5–10 cm diam., corymbiform, broadly rounded, terminal; peduncles 5–10 mm long. **Capitula** 5–6-flowered; involucre 10–13 × 3–5 mm, narrowly campanulate; phyllaries ca. 5-seriate, glabrous or apex very sparsely arachnoid-ciliate; outer phyllaries 2–4 × 1.5–3 mm, broadly ovate, apex acute; inner

phyllaries 8–11 × 1.4–2.4 mm, oblong, apex obtuse to rounded. **Florets**: corolla 9–12 mm long, lavender, glandular almost throughout, lobes ca. 1/3 length of corolla. **Cypselae** 4–6.5 mm long, obconic-prismatic maturing elongate and terete; equally 10-costate or sometimes 3–4-angled with outer face rounded and smooth (my interpretation is that in this species, as in *E. littoralis*, cypsela position in the capitulum often determines cypselae shape, with the outer fruits round-faced abaxially and the inner fruits more evenly costate), glandular almost throughout or distally (I interpret the structures in the furrows as true glands, rather than as large idioblasts), otherwise glabrous, never densely setiferous, apical callose zone narrow; pappus 1-seriate, inner bristles 7–8.1 mm long.

Distribution and Ecology. *Eremosis shannonii* is endemic to Chiapas (Mexico) and Guatemala, where it occurs in mixed forest, mountain slopes, oak forest, pine-oak forest, and selva nublada from about 2500–3800 meters elevation and flowers from December to February.

Representative collections. **MEXICO. Chiapas.** *Breedlove 11493* (CAS, NY); *Breedlove & Thorne 31196* (CAS, MO, NY, TEX). **GUATEMALA**. *Keeley & Keeley 3161* (MO); *Williams et al. 22913* (NY); *Williams 25845* (NY).

Maturing fruits of *E. shannonii* have much in common with those of *E. mima*: both are obconic-prismatic, and have a uniseriate pappus of bristles that are slightly non-contiguous at base. The cypselae may be several broad-ribbed in *E. shannonii*, which is further distinguished by its leaf blades abaxially glabrous arachnoid-tomentulose to glabrate, never with dense obvious patent indumentum found in *E. mima*.

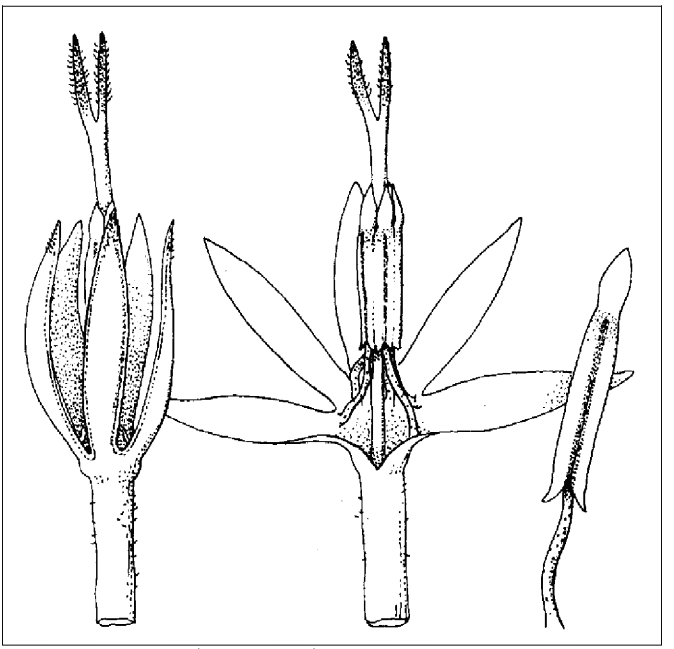

Figure 14. *Eremosis standleyi*, florets (left and center) showing the nearly throatless corollas with lobes deeply cut to near tube, and on right an anther. Drawn by M. Pahl and reproduced from Nash (1976).

7. EREMOSIS STANDLEYI (S.F. Blake) Pruski, **comb. nov.** *Vernonia standleyi* S.F. Blake, J. Wash. Acad. Sci. 13: 143. 1923. **TYPE: EL SALVADOR**. Near Santa Ana, 655–800 m, 8 Jan 1922, *Standley 19703* (holotype: US; isotypes: GH, NY). Figures 14–15.

Critoniopsis standleyi (S.F. Blake) H. Rob., *Vernonia calderonii* S.F. Blake

Figure 15. Representative specimen of *Eremosis standleyi* (*Renderos et al. 573*, MO).

Shrubs 1–3 m tall; stems finely tomentulose and glandular becoming glabrate, sometimes slightly fractiflex. **Leaves** short-petiolate; blade 4–12 × 1.5–5 cm, elliptic to obovate, usually widest at or above the middle, 2° veins usually 5–9 per side, adaxial surface finely puberulent especially along the midrib and glandular, abaxial surface densely pilosulose to tomentose, pubescent with simple non-glandular trichomes, also glandular, base cuneate, margins entire to serrulate, apex acute to acuminate (infrequently obtuse); petiole 2–7 mm long. **Capitulescences** of sessile (infrequently on short stalks 1–2 cm long) rounded dense axillary glomerules 1–2.3(–3) cm diam., capitula subsessile on peduncles to 1 mm long. **Capitula** 4–5-flowered; involucre 4–5.5 × 2–3 mm, campanulate; phyllaries 5–7-seriate, distal 1/2 arachnoid to villous and also glandular, outer phyllaries 1–1.5 × 0.5–1 mm, ovate, apex acute to obtuse; inner phyllaries 4–5.5 × 1–1.4 mm, lanceolate, apex acute to acuminate. **Florets**: corolla 4–5 mm long, ochroleucous, glandular and sometimes also hispidulous especially on tube, lobes to ca. 2.5 mm long, about 1/2 length of corolla, cut to base of the nearly absent throat, with the anthers thereby basically fully exserted and full exposed. **Cypselae** 2–3.5 mm long, strongly 5–8-costate, pilose to densely sericeous, apical callose zone to ca. 0.1–0.3 mm long but tardily elongated, glabrous, slightly constricted; pappus 2-seriate, inner bristles 3.7–5 mm long.

Distribution and Ecology. *Eremosis standleyi* is endemic to Central America (El Salvador, Guatemala, Honduras, Nicaragua), where it is moderately common and occurs in Acacia scrub, shrubby areas, pine forests, and pine-oak forests. It has been collected from about 600–1400 meters elevation and flowers from September to March.

Representative collections. **EL SALVADOR.** *Calderón 2499* (F-2, US; type of synonymous *Vernonia calderonii*); *Monro et al. 2833* (B, BM, LAGU, MO); *Renderos et al. 573* (B, BM, K, LAGU, MO). **GUATEMALA.** *Standley 60489* (NY); *Standley 74968* (F, US). **HONDURAS.** *Standley 28221* (MO); *Williams 23262* (NY). **NICARAGUA.** *Molina & Williams 20186* (US); *Moreno 22601* (MO); *Moreno 22722* (MO).

Although Jones (1973) suggested that *Vernonia calderonii* is a hybrid between *E. leiocarpa* and *E. standleyi*, by its long corolla lobes, and pubescent cypselae it is synonymized with *E. standleyi*. *Eremosis standleyi* is similar by pubescent fruits to *E. triflosculosa*, which generally differs by its cylindrical involucre. A fine illustration was provided by Nash (1976) in the Flora of Guatemala series, and Figure 14 reproduces the deeply lobed corollas from that illustration.

8. EREMOSIS THOMASII (H. Rob.) Pruski, **comb. nov**. *Critoniopsis thomasii* H. Rob., Phytologia 78: 388. 1995. **TYPE: HONDURAS. Comayagua.** Azul Meambar National Park, 1740 m, 11 Mar 1993, *T. Hawkins (as "Thomas") 571* (holotype: MO; isotypes: EAP, TEFH). Figures 3, 5A, 16.

Vining shrubs 4–10 m tall; stems tomentulose, non-glandular trichomes T-shaped, trichome stalk shorter than arms. **Leaves** short-petiolate; blade 2.5–9 × 1–5 cm, elliptic-ovate, usually widest at or above the middle, 2° veins usually 5–7 per side, surfaces hirtellous with simple non-glandular trichomes, adaxial surface sometimes also glandular, abaxial surface also glandular, base cuneate to obtuse, margins entire, apex acute to obtuse; petiole 0.4–0.7 cm long. **Capitulescences** terminal, pyramidal-paniculate, capitula subsessile in many clusters; peduncles 0–1.6 mm long, tomentulose with short-stalked T-shaped non-glandular trichomes. **Capitula** 3–4-flowered; involucre 4.5–6.5 × 2.5–3 mm, narrowly campanulate; phyllaries 5–6-seriate, glabrous or apex puberulent; outer phyllaries 0.6–1 × 0.4–0.6 mm, broadly ovate; inner phyllaries 4–5 × 1–1.4 mm, oblanceolate, apex acute. **Florets:** corolla 4.6–5.8 mm long, white, glandular distally, lobes ca. 1.5 mm long, ca. 1/3 length of corolla. **Cypselae** 2–2.3 mm long, ca. 3–7-costate, setulose-substrigillose to pilose, non-glandular, apical callose zone to ca. 0.1 mm long, glabrous; pappus bristles ca. 4.5 mm long, 1–2-seriate.

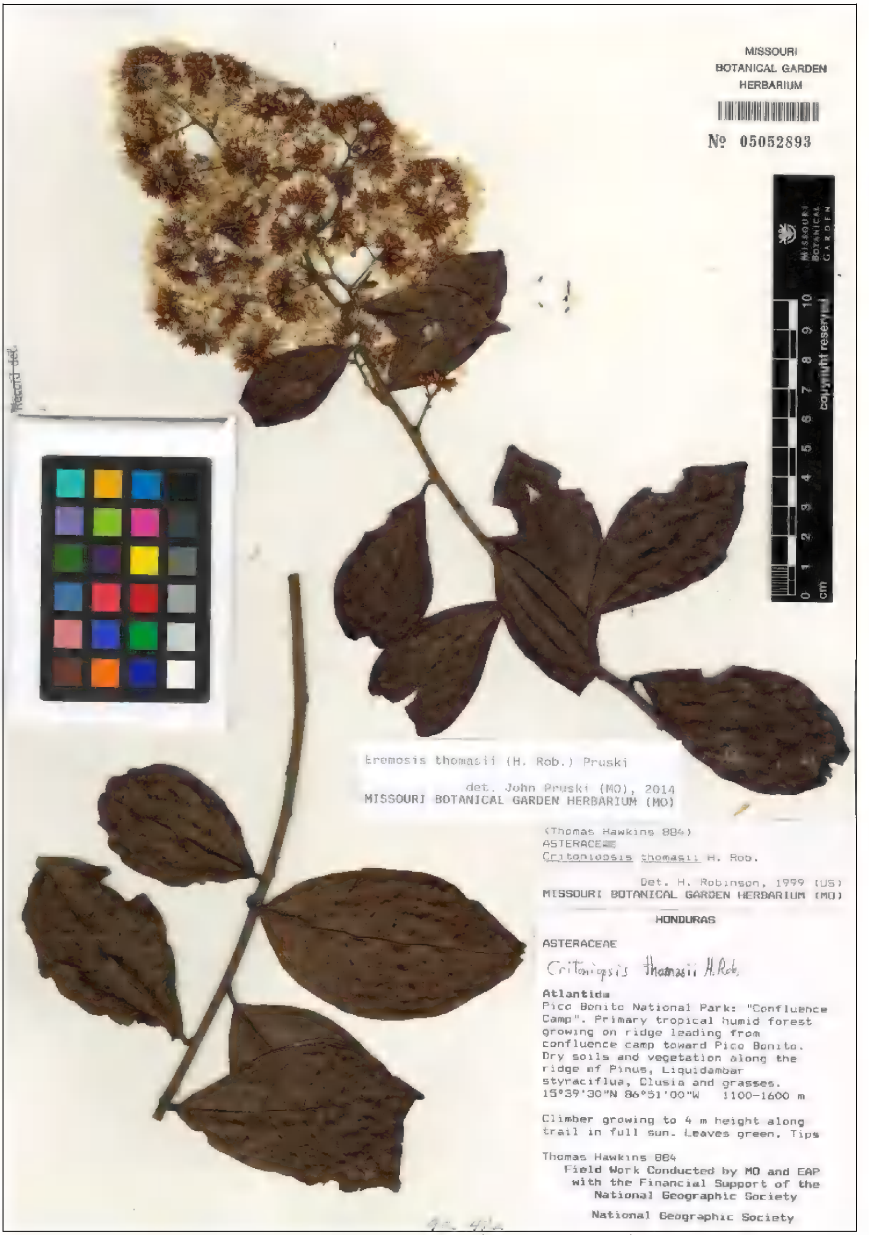
MISSOURI
BOTANICAL GARDEN
HERBARIUM
№ 05052893
Eremosis thomasii (H. Rob.) Pruski
det. John Pruski (MO), 2014
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)
(Thomas Hawkins 884)
ASTERACEAE
Critoniopsis thomasii H. Rob.
Det. H. Robinson, 1999 (US)
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)
HONDURAS
ASTERACEAE
Critoniopsis thomasii H.Rob.
Atlantida
Pico Bonito National Park: "Confluence Camp". Primary tropical humid forest growing on ridge leading from confluence camp toward Pico Bonito. Dry soils and vegetation along the ridge of Pinus, Liquidambar styraciflua, Clusia and grasses.
15°39'30"N 86°51'00"W 1100-1600 m
Climber growing to 4 m height along trail in full sun. Leaves green. Tips
Thomas Hawkins 884
Field Work Conducted by MO and EAP with the Financial Support of the National Geographic Society
National Geographic Society

Figure 16. Representative specimen of *Eremosis thomasii* (*Hawkins 884*, MO).

Distribution and Ecology. *Eremosis thomasii* is endemic to Honduras, where it occurs in moist forests from about 1100–1700 meters elevation and flowers from March to April.

Representative collection. HONDURAS. *Hawkins 884* (MO).

Eremosis thomasii is one of only two known species with T-shaped non-glandular trichomes. Robinson (1995) described the non-glandular trichomes as stellate, but the stellate or dendroid structures seen by me are mostly on mature leaves only, and are very thin, about an order of magnitude thinner than the T-shaped trichome stipe cells. It seems that the material seen by me is infected with fungal hyphae and that the species may not be stellate-pubescent.

9. EREMOSIS TRIFLOSCULOSA (Kunth) Gleason, Bull. New York Bot. Gard. 4: 233. 1906. *Vernonia triflosculosa* Kunth, Nov. Gen. Sp. (folio ed.) 4: 31. 1820 [1818]. **TYPE: MEXICO. Guerrero**. Acaguisotla, Feb 1803 [the Sprague itinerary (1924: 21; 1968: 96) gave month as "April"], *Humboldt & Bonpland 3909* (holotype: P-HBK, as IDC microfiche 6209 92.I.2, as Macbride neg. 37347; isotypes: B-W-15178 (as IDC microfiche 7440 card 1092), P-RICHARD, P-SCH-BIP).

Cacalia triantha (Schauer) Kuntze, *Cacalia triflosculosa* (Kunth) Kuntze, *Critoniopsis triflosculosa* (Kunth) H. Rob., *Gymnanthemum congestum* Cass., *Vernonia dumeta* Klatt, *Vernonia luxensis* J.M. Coult., *Vernonia triantha* Schauer

Shrubs or trees (2–)4–12 m, crowns dense and rounded; stems canescent or tomentose becoming glabrate, non-glandular trichomes simple. **Leaves** short-petiolate; blade 5–13 × 1–3 cm, oblanceolate to obovate, usually widest above the middle, 2° veins usually 5–7 per side, adaxial surface puberulent to commonly glabrate, abaxial surface glandular, otherwise glabrous to subtomentulose with simple non-glandular trichomes, base obtuse to more commonly acuminate to attenuate and subdecurrent, margins entire to serrulate or denticulate, apex acute to acuminate; petiole 0.4–1.2(–1.7) cm long. **Capitulescences** terminal rounded-paniculate, capitula subsessile in numerous clusters. **Capitula** 3(–4)-flowered; involucre 4.5–6.5 × 1.3–2.5 mm, cylindrical; phyllaries 4–6-seriate, mostly subglabrous, especially proximally; outer phyllaries 0.5–1 × 0.7–1.4 mm, broadly ovate, apex obtuse to rounded, often with midrib visible, somewhat greenish and glandular or puberulent; inner phyllaries 3.5–6.5 × 1–1.6 mm, oblanceolate, apex acute, seemingly more fragile than in many species. **Florets**: corolla 5–6 mm long, white, throat present, lobes to 1.5 mm long, usually 1/3–1/4 length of corolla. **Cypselae** 2–3 mm long, at maturity 3–6-striate-costate, setose, also glandular, the glabrous apical callose zone only moderately developed throughout much of fruiting and often obscured by cypsela body trichomes, infrequently collected in late fruit with tardily well-developed callose zone to ca. 0.2(–0.4) mm long; pappus 1–2-seriate, a few shorter outer bristles sometimes present but not as a well-defined ring and not imparting a double pappus appearance to fruit, inner bristles 4–5.5 mm long.

Distribution and Ecology. *Eremosis triflosculosa* is widespread from central Mexico (centered in Chiapas, Colima, Guerrero, Hidalgo, Jalisco, México, Morelos, Nayarit, Oaxaca, Veracruz) southeastwards into Panama, where it is known from a single collection. *Eremosis triflosculosa* occurs in deciduous forests, fields, forested rocky slopes, matorrales secos, pastizal, rocky hillsides, secondary vegetation, selva baja caducifolia, and thickets in Central America from about 100–1600 meters elevation and flowers from February to June. The citation by Turner (2007: 133) of *E. triflosculosa* in Quintana Roo, Mexico is presumably based on material of *E. oolepis*, and Carnevali et al. (2010) listed only *E. oolepis* in the Yucatán Peninsula.

Table I. Nine informal species groups (and 27 species) of *Eremosis* and some of their key characters. The relative placements of three synonyms, each perhaps meriting recognition, are indicated. [1–9 are morphotype group numbers; M = species present in Mesoamerica; ME = Mesoamerican endemic species].

1. Cypselae glabrous or subglabrous (or sometimes glandular, not densely setiferous) and capitula pauciflorous.	*E. heydeana* M *E. leiocarpa* M *E. littoralis* *E. mima* ME *E. pugana* *E. shannonii* ME
2. Capitula typically uniflorous; cypselae glandular and characteristically 7–10-ribbed, otherwise glabrous or sparsely setose; leaf blades typically discolorous, tomentose to sparsely so or even subglabrous abaxially.	*E. macvaughii* *E. obtusa* [?syn. *V. duncanii*]
3. Capitula typically uniflorous; cypselae obviously setiferous, sometimes also glandular; leaf blades discolorous, tomentose abaxially.	*E. aristifera* *E. tomentosa*
4. Capitula uniflorous; cypselae obviously setiferous, sometimes also glandular; leaf blades relatively large, not densely tomentose.	*E. baadii* *E. solorzanoana* *E. steetzii* [?syn. *V. macphersonii*]
5. Capitula typically uniflorous; cypselae obviously setiferous, sometimes also glandular; leaf blades relatively small, not densely tomentose.	*E. angusta* ME *E. corymbosa* [syn. *V. salicifolia*] [syn. *V. uniflora*] *E. foliosa* *E. pallens*
6. Capitula pauciflorous; cypselae setiferous, sometimes also glandular; corollas nearly throatless with lobes cut to near tube.	*E. palmeri* *E. standleyi* ME
7. Capitula pauciflorous; cypselae setiferous, sometimes also glandular; leaf blades discolorous, tomentose abaxially.	*E. ovata* *E. tarchonanthifolia*
8. Capitula pauciflorous; cypselae setiferous, sometimes also glandular; phyllaries decurrent onto peduncles.	*E. feddemae*
9. Capitula pauciflorous; cypselae setiferous, sometimes also glandular; corolla with throat; leaves concolorous to slightly discolorous, not densely tomentose abaxially.	*E. barbinervis* *E. oolepis* ME *E. thomasii* ME *E. triflosculosa* M *E. villaregalis*

Representative collections. **COSTA RICA.** *Bello 824* (CR, MO, TEX); *Brenes 1903* (NY); San Francisco de Guadalupe, 13 May 1894, *Pittier 8767* (BR-2, F, G, GH; type of synonymous *Vernonia dumeta*); Golfo Dulce, May 1896, *Tonduz 7076/8767* (MO, US); San Francisco de Guadalupe, 5 May 1896, *Tonduz 8767* (P, presumably either the locality or the year is erroneous); *Tonduz 13894* (MO). **EL SALVADOR.** *González 20* (B, K, LAGU, MO); *Standley 21810* (NY); *Standley 23404* (GH, NY, US). **GUATEMALA.** *Heyde & Lux 3421* (K, US); *Rojas 267* (MO); *Standley 64935* (NY); *Standley 88043* (NY); *Véliz 99.6942* (BIGU, MO). **HONDURAS.** *Molina 2717* (F, GH); *Valerio 2471* (MO); *Williams & Molina 12115* (MO). **MEXICO. Chiapas.** *Breedlove 24648* (CAS, MO); *Breedlove 50984* (CAS, NY); *Matuda 1561* (GH, MEXU, MO, NY); *Ventura & López 1204* (MO, XAL); *Ventura & López 1217* (MO, XAL). **Jalisco.** *McVaugh 10208* (MEXU, MICH, NY). **Oaxaca.** *Maya 3036* (CHAPA, MO). **Veracruz.** *Purpus 8968* (MO, NY, US); *Purpus 9016* (NY); *Ventura 11132* (MO).

NICARAGUA. *Moreno 243* (MO, NY); *Moreno 8273* (MO); *Standley 20342* (F); *Stevens 16890* (MO). **PANAMA.** *Davidson 642* (F, MO, US).

Eremosis triflosculosa is among the largest-trunked regional tree Compositae. A fine drawing of it was given in Zamora et al. (2000: 282). McVaugh (1972b) treated *E. barbinervis* and *E. palmeri* in synonymy with *E. triflosculosa*, whereas Jones (1973) recognized each, albeit with only two as species and the third as an infraspecies. Here I follow Gleason (1906, 1922) and recognize each at the specific rank. Thus, the northern lanceolate-leaved *V. triflosculosa* subsp. *palmeri* (Rose) S.B. Jones (1973), differing by nearly throatless corollas, is recognized here as *E. palmeri*, which I related more closely to *E. standleyi* than to either *E. barbinervis* or *E. triflosculosa*. In turn, I recognize *E. triflosculosa* in the restricted sense of *V. triflosculosa* subsp. *triflosculosa* sensu Jones (1973). Of the more common species in Central America, *E. triflosculosa* is characterized by its generally narrower less pubescent leaves and narrower capitula.

ANNOTATED NOMENCLATOR OF *EREMOSIS*.

EREMOSIS ANGUSTA Gleason. **Type, distribution, and representative collection**. Guatemala; see species #1 above.

EREMOSIS ARISTIFERA (S.F. Blake) Pruski, **comb. nov.** *Vernonia aristifera* S.F. Blake, Contr. U.S. Natl. Herb. 23: 1415. 1926. **TYPE: MEXICO. Jalisco.** Río Blanco, 1886, *Palmer 678* (holotype: US; isotypes: GH, K p.p., MEXU, MO, NY, NDG, YU).

Vernonia steetzii var. *aristifera* (S.F. Blake) McVaugh

Key features. Shrubs 1–2 m tall; leaf blades 3.5–6 × 2.2–4.5 cm, obviously discolorous, persistent tomentose abaxially; capitula usually 1-flowered; inner phyllaries often purplish, aristate; cypselae sericeous. $2n = 36$ (Jones 1973; voucher *Jones et al. 20583* as *V. steetzii*).

Distribution and representative collections. Mexico (Jalisco, ?San Luis Potosí): *Jones et al. 20583* (GA, MO); "chiefly in the region of San Luis Potosí" (but perhaps more to the SW and in Jalisco as in McVaugh 1984: 1035), *Parry & Palmer 332* (F, GH, MO, NY); *Pringle 1823* (F, GH, MO, NY, US); *Pringle 9993* (GH, MO).

Material of obviously discolorous-leaved *E. aristifera* (before it was described) was treated by Gleason (1906, 1922) as *E. callilepis*, but that is a less pubescent-leaved species recognized here as *E. foliosa*. Blake et al. (1926) commented on the presumed name misapplication of Gleason. Nevertheless, material of *E. aristifera* passed again as a broadly circumscribed *E. steetzii* in both Jones (1973) and Turner (2007) and as *E. foliosa* in Robinson (1999a), but *E. aristifera* is here resurrected from synonymy.

EREMOSIS BAADII (McVaugh) Pruski, **comb. nov.** *Vernonia salicifolia* var. *baadii* McVaugh, Contr. Univ. Michigan Herb. 9: 484. 1972. **TYPE: MEXICO. Jalisco.** 20 km SE Talpa de Allende, 2–3 Apr 1965, *McVaugh 23473* (holotype: MICH; isotypes: CAS, DUKE, ENCB).

Critoniopsis baadii (McVaugh) H. Rob., *Vernonia baadii* (McVaugh) S.B. Jones

Key features. Shrubs to trees 3–5 m tall; leaves relatively long-petiolate, blades 11–20 × 3–6 cm, relatively long and narrow, surfaces nearly concolorous, glabrous adaxially, glandular abaxially; capitula 1-flowered; cypselae sericeous.

Distribution and representative collection. Mexico (Jalisco, Michoacán): *Mexia 1904* (F, MO, NY, US).

Eremosis baadii is similar to, and may be best considered a segregate of, short-petiolate *E. steetzii*.

EREMOSIS BARBINERVIS (Sch. Bip.) Gleason, Bull. New York Bot. Gard. 4: 232. 1906. *Vernonia barbinervis* Sch. Bip. in Seemann, Bot. Voy. Herald 297. 1856. **TYPE: MEXICO. Nayarit.** Sierra Madre, 1848–1850, *Seemann 1998* (holotype: P-SCH-BIP; isotypes: GH, K).

Cacalia barbinervis (Sch. Bip.) Kuntze, *Critoniopsis barbinervis* (Sch. Bip.) H. Rob.

Key features. Shrubs 1–2 m tall; leaf blades 9–16 × 3–10 cm, surfaces concolorous; capitula usually 3-flowered; cypselae sericeous.

Distribution and representative collections. Mexico (Durango, Sinaloa, Zacatecas): *Gentry 5305* (F, MO, NY, US); *Gentry 5539* (GH, MEXU, MO, NY).

Schultz Bipontinus (1856) described *V. barbinervis* as a species of triflorous *Vernonia* sect. *Trianthaea* DC. At that time (1856) *Vernonia* sect. *Eremosis* was still considered to contain only uniflorous species.

EREMOSIS CALLILEPIS (Sch. Bip.) Gleason, N. Amer. Fl. 33: 98. 1922. = **Eremosis foliosa** (Benth.) Gleason

EREMOSIS CORYMBOSA (Mill.) Pruski, **comb. nov.** *Conyza corymbosa* Mill., Gard. Dict. (ed. 8) Conyza no. 7. 1768. **LECTOTYPE** (designated here): **MEXICO.** Probably western Veracruz ["Grows naturally at La Vera Cruz"], 1731, *Houstoun s.n.* (lectotype: BM [BH neg. 5267], photographs BH, E, MO, NY; possible isolectotype: BM-SLOANE 292.64, not seen). There does not appear to be any extant Chelsea garden material grown by Philip Miller (viz Pruski 2005). The lectotype bears the hand-written note "see also Herb. Sloane 292.64." Although the type locality was given as La Vera Cruz, the plants were presumably collected inland. Figures 1, 7, 11.

Cacalia baptizanda Kuntze (a nom. nov. for *Vernonia uniflora* Sch. Bip.), *Critoniopsis salicifolia* (DC.) H. Rob., *Critoniopsis uniflora* (Sch. Bip.) H. Rob., *Eremosis leiophylla* Gleason, *Eremosis salicifolia* (DC.) Gleason, *Eupatorium uniflorum* Sessé & Moc., *Monosis salicifolia* DC., *Vernonia salicifolia* (DC.) Sch. Bip. 1847 (non (Mart.) Less. 1829), *Vernonia leiophylla* (Gleason) S.F. Blake, *Vernonia uniflora* Sch. Bip.

Key features. Shrubs 1–3.5 m tall; leaf blades 4–9(–12) × 1–3(–4.5) cm, surfaces nearly concolorous; capitula usually 1(–2)-flowered; inner phyllaries often evenly drying purplish and then strongly contrasting in color with the pappus; corollas purplish; pollen Type A (viz Robinson 1999a: Fig. 1A–B as *Critoniopsis uniflora*); cypselae sericeous. $2n = 74$ +/- 2 as *V. salicifolia* (Jones 1973), tetraploid.

Distribution and representative collections. Mexico (Aguascalientes, Colima, Guerrero, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Veracruz, Zacatecas): *Arsène & Nicholas 5083* (GH, MO, US); 20 Oct 1827, *Berlandier 968* (G-DC p.p., LD, MO, NY, US, W; lectotype collection of synonymous *Monosis salicifolia*); 21 Oct 1827, *Berlandier 1047* (G-DC p.p., HAL, P, US; syntype collection of synonymous *Monosis salicifolia*); *Jones 21681* (GA, MO);

Matuda 30244 (NY, US); *Mexia 9108* (F, GH, MO, NY, UC, US; neotype of *Vernonia uniflora*); *Pringle 6188* (BR, F, GH, GOET, MICH, MO, NDG, NY, S, UC, US; type of synonymous *Eremosis leiophylla*); *Pringle 13908* (MO, US); *Rzedowski 36063* (MO); *Sessé & Mociño 2735* (F-2, MA-2; lectotype of synonymous *Eupatorium uniflorum* Sessé & Moc.); *Sessé & Mociño 3931* (MA, microfiche BT-13 267.A3, F neg. 42897; syntype of *Eupatorium uniflorum* Sessé & Moc.).

Typology of *Monosis salicifolia* DC. *Monosis salicifolia* DC., Prodr. 5: 77. 1836. *Vernonia salicifolia* (DC.) Sch. Bip., Linnaea 20: 507. 1847 [non (Mart.) Less. 1829]. *Eremosis salicifolia* (DC.) Gleason, Bull. New York Bot. Gard. 4: 231. 1906. *Critoniopsis salicifolia* (DC.) H. Rob., Proc. Biol. Soc. Washington 106: 621. 1993. **LECTOTYPE** (effected by Jones 1973: 112): **MEXICO. Morelos.** Ad Cuernavaca, 20 Oct 1827, *Berlandier 968* (lectotype: G-DC p.p., plant on the left, and likely also the plant in center of sheet, as IDC microfiche 800 781.I.5, as Macbride neg. #33568; isolectotypes: LD, MO, NY, P-2, US, W). Brazilian *Cacalia salicifolia* (Mart.) Less. was given incorrectly as a homotypic synonym by Redonda-Martínez and Villaseñor-Ríos (2009).

On the typification of *Monosis salicifolia* DC. The lectotype sheet of *Monosis salicifolia* has three twigs: that on far right is the syntype *Berlandier 1047* from Cordillera de Guchilaqua; and two others constitute the lectotype proper (*Berlandier 968*, G-DC) from Cuernavaca. The two twigs on the lectotype towards the left are considered here as of the same gathering, albeit having subtle label differences, and perhaps sent to Candolle at different times. The center twig is sub-labeled 6ex and dated "20/10 1827" and that on the far left sub-labeled 19ex (?in reference to the Linnaean sexual system?) and dated as "8bre," an early French shorthand for October sometimes misread as the 8th month (August). *Berlandier 1047* (G-DC p.p. twig on right, HAL, P, US) from Guchilaqua is dated 21 Oct 1827. A third original element of the Candolle name is the drawing of Sessé and Mociño collection cited as "fl. mex. mss. and now at CM [Illustr. Hunt Institute (Torner) 6331.0241 = Ic. Fl. Mex.164] (reproduced here as Fig. 1).

Lectotypification of *Eupatorium uniflorum* Sessé & Moc. *Eupatorium uniflorum* Sessé & Moc., Pl. Nov. Hisp. 132. 1887 [1890]; Pl. Nov. Hisp. (ed. 2) 123. 1893. *Critoniopsis uniflora* (Sch. Bip.) H. Rob., Proc. Biol. Soc. Washington 106: 625. 1993. **LECTOTYPE** (chosen here from among syntype elements): **MEXICO**. 1787–1790(–1803) [see Sprague 1926], "Xochixtlam and Mexicanorum Carmelitarum Eremo," *Sessé & Mociño 2735* (lectotype: MA (as microfiche BT-13 267.A2, F neg. 42893); presumed isolectotypes: F-2, MA (as microfiche BT-13 267.A1, F neg. 42896)).

On the typification of *Eupatorium uniflorum* Sessé & Moc. I have seen four sheets of *Sessé & Mociño 2725* as numbered by Standley, and the short diagnosis of "calycibus unifloris foliis lanceolatis … 8 ped" on the MA lectotype corresponds to the protologue. The isolectotype in MA, although presumed to be of the same gathering but perhaps from a shorter individual (as allowed by the ICBN) and reads "Eupatorium corymbosum N …. frutex sexpedalis … folia oblonga" and perhaps also "No. 59." Each of the four lectotype collection sheets seen are robust, and Icon. Fl. Mex. 164 (Fig. 1) does not appear to have been drawn from them. Rather, Fl. Mex. 164 matches fairly well *Sessé & Mociño 3931* (MA), which is labeled "Seriphium corimbosum," as is the color plate. *Sessé & Mociño 3931* (MA) is intentionally not chosen as the lectotype. Thus as lectotypified *V. uniflora* and *V. salicifolia* are heterotypic. I do not know, however, which Sessé and Mociño collection is from which cited locality: Xochitlán (Morelos) and Carmelitarum aka Desierto de los Leones (Distrito Federal) (viz Sprague 1926; McVaugh 1980). Redonda-Martínez and Villaseñor-Ríos (2009) listed the black and white copy in G (Field neg. 30707) of Icon. Fl. Mex. 164 as the holotype of *Eupatorium uniflorum*. Although perhaps Mociño did see this black and white copy (McVaugh 2000: 158 suggested the annotation on it may be in Mociño's hand) of the original color plate, the citation of the copy illustration in G as holotype by Redonda-Martínez and Villaseñor-Ríos (2009) is

not followed here. Moreover, the type citation in Redonda-Martínez and Villaseñor-Ríos (2009) is post-2000 and does not effect typification (viz ICBN 7.10). Here, a lectotype of *Eupatorium uniflorum* is chosen from purple-phyllaried material collected by Sessé and Mociño deposited in MA. Even though I prefer basically to typify only recognized names, here I hope to fix application by proposing *Sessé & Mociño 2735* as lectotype for *Eupatorium uniflorum* (viz Sessé and Mociño 1887, 1893). This lectotype material has phyllaries drying the same color as in heterotypic *V. uniflora* Sch. Bip., and each is treated here in synonymy with *E. corymbosa*. Should the color forms prove specifically distinct, I would continue to equate taxonomically *Mexia 9108* (the neotype of *V. uniflora* 1847) and *Sessé & Mociño 2735* (the lectotype of *E. uniflorum* 1887 [1890]). The name *Eremosis uniflora* (Sch. Bip). ined. is available for the more purple-flowered segregate of *E. corymbosa*.

The available name *E. corymbosa* is adopted here, although long-blocked in *Vernonia* by *V. corymbosa* Schwein. Candolle (1836), Gleason (1906, 1922), Blake et al. (1926), and Turner (2007) each treated *V. uniflora* (or in the case of Candolle what was to become *V. uniflora*) in synonymy with *E. corymbosa*. I agree that there seems to be no great geographic separation of the (?drying influenced) color forms, and morphologies apparently grade into one another. Seaman (1982) gave the sesquiterpene lactones glaucolide D and glaucolide E as having been reported in *V. salicifolia* and *V. uniflora*, each treated here in synonymy of *E. corymbosa*. Elsewhere in *Eremosis*, differing glaucolide types within multiple exsiccate of a single species have also been noted. Schultz Bipontinus (1861) allied the two species, but it is not clear to me if he intended to treat them as the same. On the other hand, many authors recognized *E. corymbosa* (syn. *E. salicifolia*) and *V. uniflora* as distinct (Schultz Bipontinus 1847; Hemsley 1881; Jones 1973, 1979a; McVaugh 1984; Robinson 1993, 1999a; García 2004; Redonda-Martínez and Villaseñor-Ríos 2009).

As broadly circumscribed here, *E. corymbosa* is most distinctive by uniflorous capitula and its usually purplish phyllaries, as described in both the Sessé and Mociño (1887, 1893) and Schultz Bipontinus (1847) protologues, and as drawn clearly in Icon. Fl. Mex. 164 (Fig. 1). This commonly collected purple-phyllaried phase was called *V. uniflora* by Jones (1973) and McVaugh (1984), and the less frequent pale or faded acute-tipped phyllary form as *E. salicifolia*. The Miller (1768) protologue of *E. corymbosa* gives "floribus singulis" and "white," and the phyllaries of the lectotype collected in 1731 are not obviously purple (Fig. 11). Icon. Fl. Mex. 164 also is an original element of *V. salicifolia*, and Candolle (1836) took both color forms as a single species. The apex of outer few series of phyllaries of the drying pale color form are often thickly midribbed, broadly obtuse, arachnoid-pubescent, and glandular, more so in the purplish flower form. About 1/4 of material in front of me, however, has faded acute-tipped phyllaries as in what Jones (1973) called *V. salicifolia*, that grades into the more purplish-flower forms. *Eremosis corymbosa*, by its glandular weakly pubescent leaves, uniflorous capitula, and sericeous cypselae, however, is also clearly similar to *E. barbinervis* (Sch. Bip.) Gleason and *E. pallens* (Sch. Bip.) Gleason. Britten (1898) identified the lectotype of *E. corymbosa* as *E. tarchonanthifolia*, which differs by its abaxially tomentose leaves and pauciflorous capitula.

There are several recent examples (i.e., Blake 1930; Cabrera 1959; D'Arcy 1973; Robinson 1999a; Pruski 2005) of recognition in other genera of Miller (1768) species described in *Conyza*. Of the 18 Conyzas in Miller's Gard. Dict., ed. 8 (1768), seven are Linnaean names and 11 are Neotropical plants newly described by Miller (viz Miller 1768; Britten 1898). Five Miller (1768) Conyzas are either synonyms or blocked in currently recognized genera. The six Miller (1768) Conyzas currently recognized are placed in tribes Astereae, Inuleae, or Vernonieae and include dioecious, discoid, and disciform plants; i.e., *Baccharis pedunculata* (Mill.) Cabrera, *Eremosis corymbosa* (Mill.) Pruski, *Lepidaploa uniflora* (Mill.) H. Rob., *Pluchea baccharis* (Mill.) Pruski, *Pluchea salicifolia* (Mill.) S.F. Blake, *Pseudoconyza viscosa* (Mill.) D'Arcy.

EREMOSIS FEDDEMAE (McVaugh) Pruski, **comb. nov.** *Vernonia feddemae* McVaugh, Contr. Univ. Michigan Herb. 9: 480. 1972. **TYPE: MEXICO. Nayarit**. 5 km NE of Puga, 22 Aug 1959, *Feddema 846A* (holotype: MICH).

Critoniopsis feddemae (McVaugh) Redonda-Martínez & Villaseñor

Key features. Perennials to 1.5 m tall; leaf blades 5–12 × 1.5–5 cm, surfaces slightly discolorous, abaxial surfaces sparsely arachnoid-tomentose; phyllaries decurrent onto peduncles; capitula 3–5-flowered; cypselae pilose-sericeous. McVaugh (1972a: 481) provided a fine figure of this pauciflorous pluricephalous perennial.

Distribution and representative collection. Mexico (Nayarit): known only from the type.

Eremosis feddemae is unique in *Eremosis* by its phyllaries strongly decurrent onto peduncles, resembling in this regard *Critoniopsis jaramilloi* Pruski & H. Rob., the only species of *Critoniopsis* with this character.

EREMOSIS FOLIOSA (Benth.) Gleason, Bull. New York Bot. Gard. 4: 228. 1906. *Monosis foliosa* Benth., Pl. Hartw. 19. 1839. **TYPE: MEXICO. Jalisco.** Bolaños, 1837, *Hartweg 133* (holotype: K; isotypes: BM, E, LD, NY-2, P, W). Figure 17.

Critoniopsis foliosa (Benth.) H. Rob., *Eremosis callilepis* (Sch. Bip.) Gleason, *Eremosis steetzii* var. *callilepis* (Sch. Bip.) Gleason, *Vernonia foliosa* (Benth.) Sch. Bip. 1861 (non Gardner 1846), *Vernonia mucronata* S.F. Blake (a nom. nov. for *Monosis foliosa* Benth.), *Vernonia steetzii* var. *callilepis* Sch. Bip.

Key features. Shrubs to 2 m tall; leaf blades relatively small, mostly 4–6 cm long, reticulate, glandular, tomentulose abaxially, but nevertheless more or less concolorous; capitula 1-flowered; cypselae sericeous.

Distribution and representative collections. Mexico (centered in Durango, Jalisco, Nayarit, Zacatecas; possibly also present in Aguascalientes, Guanajuato, and Nayarit as inferred from the wide distribution given by Rzedowski and Calderón de Rzedowski 1995a: 44 for a broadly circumscribed of *E. steetzii*): *Seemann 1997* (K, P-SCH-BIP dextrum, but P now cut and remounted on single sheet; type of synonymous *Vernonia steetzii* var. *callilepis*); *Tenorio & Flores 16721* (MEXU, MO).

Blake et al. (1926) commented that they thought Gleason (1922) misapplied names now recognized as *E. aristifera*, *E. foliosa*, and *E. steetzii*. Blake et al. (1926) used the homotypic new name *V. mucronata* (1917) for *Monosis foliosa*, and described *V. aristifera* as new. *Eremosis aristifera* was not recognized subsequently by Jones (1973), McVaugh (1984), Rzedowski and Calderón de Rzedowski (1995a), or Turner (2007), each of whom applied the name *E. steetzii* (non Brazilian *V. foliosa* Gardner) for this species much in the sense of Gleason (1922). Robinson (1993) treated each *E. aristifera* and *E. steetzii* as synonyms. About three decades ago (viz Fig. 17), however, while working on uniflorous species of *Piptocarpha* and *Piptocoma* for the Flora of the Guayana Highland (Pruski 1997), I noted that there appears to be several "kinds" of *E. foliosa*. I was working at NY with much of the same material Gleason used about a century ago, but the NY material was not annotated by Blake, and then-recent material was determined mostly as a broadly defined *E. steetzii*. It was not clear to me which taxonomic entity matched which name.

Figure 17. Isotype of *Monosis foliosa* Benth. [≡ *Eremosis foliosa* (Benth.) Gleason] (*Hartweg 133*, NY).

Now I feel more confident and apply the name *E. foliosa* to relatively small non-tomentose usually not obviously discolorous leaved uniflorous plants with sericeous cypselae. Following Blake et al. (1926), I treat *E. aristifera* as a relatively small tomentose discolorous-leaved uniflorous plant with mucronate-aristate often purplish inner phyllaries and sericeous cypselae. I restrict the concept of *E. steetzii* to relatively short-petiolate large-leaved non-tomentose uniflorous plants with sericeous cypselae. Small-denticulate-leaved uniflorous *E. callilepis* was treated in synonymy with *E. steetzii* by Jones (1973) and Turner (2007), but is here referred to *E. foliosa*. As circumscribed here, *E. foliosa* and *E. aristifera* are very similar in leaf and capitulescence size and shape to *E. obtusa*, which is a uniflorous species with glandular otherwise subglabrous cypselae. *Eremosis foliosa* was illustrated (as *V. steetzii*) in García (2004: 346), and his plants are the more or less concolorous leaved forms treated here as *E. foliosa*.

EREMOSIS HEYDEANA (J.M. Coult.) Gleason. **Type, distribution, and representative collections**. Guatemala and Mexico; see species #2 above.

EREMOSIS LEIOCARPA (DC.) Gleason. **Type, distribution, and representative collections**. Mexico and Central America; see species #3 above.

EREMOSIS LEIOPHYLLA Gleason, Bull. New York Bot. Gard. 4: 231. 1906. = **Eremosis corymbosa** (Mill.) Pruski

EREMOSIS LITTORALIS (Brandegee) Gleason, N. Amer. Fl. 33: 100. 1922. *Vernonia littoralis* Brandegee, Erythea 7: 3. 1899. **TYPE: MEXICO. Colima**. Socorro Island, Mar–Jun 1897, *Anthony s.n.* (holotype: UC; isotype: US).

Critoniopsis littoralis (Brandegee) H. Rob.

Key features. Scandent shrubs to trees to 7–15 m tall; leaf blades 6–12 × 4–10 cm, surfaces slightly discolorous, abaxial surfaces sparsely pubescent except for main veins which are densely pubescent and thereby obviously lighter in color than green adaxial surfaces; capitula ca. 8-flowered; cypselae glabrous, never densely setiferous, sometimes pluricostate.

Distribution and representative collection. Endemic to Socorro Island, Colima, Mexico; *Mason 1656* (MO, US).

EREMOSIS MACVAUGHII (S.B. Jones) Pruski, **comb. nov.** *Vernonia macvaughii* S.B. Jones, Brittonia 25: 105. 1973. **TYPE: MEXICO. Oaxaca.** 6 mi N of Huajuapan de León, 23 Mar 1972, *Jones & Jones 21664* (holotype: GA; isotypes: F, GH, MEXU, MO, NY, TEX, US).

Critoniopsis macvaughii (S.B. Jones) H. Rob.

Key features. Shrubs 2–3 m tall; leaf blades 6–13 × 2.5–6 cm, extremely discolorous, tomentose abaxially; capitula 1-flowered; cypselae glandular, otherwise glabrous, obviously 8–10-ribbed.

Distribution and representative collections. Mexico (Guerrero, Oaxaca, adjacent Puebla): *McVaugh 22288* (MICH, MO); *Soule & Prather 3188* (MEXU, MO, TEX).

Although placed in different subtribes, *Eremosis macvaughii* immediately recalls Brazilian *Eremanthus crotonoides* (DC.) Sch. Bip. and Venezuelan *Piptocoma vernonioides* (Kunth) Pruski.

EREMOSIS MELANOCARPA Gleason, Bull. New York Bot. Gard. 4: 232. 1906. = **Eremosis leiocarpa** (DC.) Gleason

EREMOSIS MIMA (Standl. & Steyerm.) Pruski. **Type, distribution, and representative collections**. Guatemala; see species #4 above.

EREMOSIS OBTUSA Gleason, N. Amer. Fl. 33: 99. 1922. **TYPE: MEXICO.** San Luis Potosí. San Rafael, Jul 1911, *Purpus 4811a* (as "4811") (holotype: NY; isotype: MEXU).

?Critoniopsis duncanii (S.B. Jones) H. Rob., *Critoniopsis obtusa* (Gleason) H. Rob., ?*Vernonia duncanii* S.B. Jones, ?*Vernonia duncanii* subsp. *bartlettii* S.B. Jones, *Vernonia obtusa* (Gleason) S.F. Blake, ?*Vernonia obtusa* var. *bartlettii* (S.B. Jones) B.L. Turner, *?Vernonia obtusa* subsp. *parkeri* S.B. Jones, ?*Vernonia obtusa* var. *parkeri* (S.B. Jones) B.L. Turner

Key features. Shrubs to 2 m tall; leaf blades 3–15 × 2–5.5(–7) cm, surfaces typically discolorous and moderately tomentose abaxially, but perhaps grading to subglabrous as in type of subsp. *parkeri*; capitula 1(–2)-flowered; cypselae glandular or idioblastic and characteristically 7–10-ribbed, otherwise glabrous or sparsely setose. $2n = 38$ for subsp. *parkeri* (Jones 1973).

Distribution and representative collections. Mexico (Hidalgo, Nuevo León, ?Querétaro, San Luis Potosí, Tamaulipas): *Jones et al. 20559* (F, GA, GH, MEXU, MICH, MO, NY, P-2, TEX, US; type of possibly synonymous *Vernonia duncanii*); *Jones 20564* (F, GA, GH, MEXU, MO, TEX, UC, US; type of possibly synonymous *Vernonia obtusa* subsp. *parkeri*); Nov 1910, *Purpus 4811* (GH, MO).

Typical uniflorous *E. obtusa* is very similar in leaf and capitulescence size and shape to *E. aristifera* and *E. foliosa*, which each differ by their sericeous cypselae. Although typical *E. ovata* has glandular costate fruits, cypselae glands and costae are not always evident in *V. duncanii* subsp. *bartlettii* and *V. obtusa* subsp. *parkeri*. Rather, in some material the developing ovaries of these two subspecies are nearly ecostate and with only poorly manifest idioblasts. These subspecies at present cannot be matched with certainty. Nevertheless, these names are provisionally included here as in Turner (2007), who remarked that the leaves of these two subspecies are weakly pubescent. Each of these three possibly synonymous names may be deserving of recognition at some rank.

Although Jones (1973: 91) noted *V. duncanii* (*Jones 20559*) has glaucolide type B and *V. obtusa* subsp. *parkeri* (*Jones 20564*) has glaucolide type F, he also reported comparable infraspecific variation in each *E. leiocarpa* and *E. corymbosa*. Moreover, elsewhere in *Eremosis* Jones (1973) also noted individual glaucolide types may be shared among species. This suggests glaucolide kinds may not always be taxonomically significant. Similarly, chromosome numbers may not be useful in species-level taxonomy. Except for two tetraploids, all species of *Eremosis* appear to be consistently diploid. Variation in ploidy level within *E. obtusa* is unconfirmed. Jones (1973) reported *V. obtusa* subsp. *parkeri* as $n = 19$, but Turner (1981) gave a count of "$n = 10$ pairs" for *V. obtusa* subsp. *obtusa* and suggested that *V. obtusa* subsp. *parkeri* may be a tetraploid. Turner, however, commented that his count needs confirmation, as $x = 9$ and $x = 10$ are base numbers of African taxa. Turner (1981) noted that the count of "$x = 10$" would represent only the second such count for *Vernonia* s. lat. in the Americas. Nevertheless, it is anticipated that further chemical and cytological studies may be taxonomically helpful within *Eremosis*, and specifically could help resolve the limits of *E. obtusa*.

EREMOSIS OOLEPIS (S.F. Blake) Gleason. **Type, distribution, and representative collections**. Yucatán peninsula in Mexico; see species #5 above.

EREMOSIS OVATA Gleason, Bull. Torrey Bot. Club 40: 331. 1913. **TYPE: MEXICO. Durango.** San Ramón, 21 Apr–18 May 1906, *Palmer 139* (holotype NY; isotypes: F, GH, K, MO, UC, US).

Critoniopsis ovata (Gleason) H. Rob., *Vernonia durangensis* S.F. Blake 1924 (a legitimate nom. nov. for *Eremosis ovata*, non *Vernonia ovata* Less.), *Vernonia gleasonii* S.F. Blake 1917, non Ekman 1914 (an illegitimate nom. nov. for *Eremosis ovata*).

Key features. Shrubs; leaf blades 6–9 × 3–5.5 cm, surfaces moderately discolorous; capitula 4-flowered; cypselae sericeous.

Distribution and representative collection. Mexico (Durango, Nayarit): long known only from the type collection; Turner (2007) cited *Solis 682* (TEX) from Nayarit.

Jones (1973) used the name *Vernonia durangensis*, because in *Vernonia* the Gleason name is blocked nomenclaturally. Pauciflorous *E. ovata* is very similar in gestalt to uniflorous *E. steetzii*. *Eremosis ovata* is known to me from only the type collection, yet for this taxon three (homotypic) names, each with a different epithet, have been variously applied.

EREMOSIS PALLENS (Sch. Bip.) Gleason, Bull. New York Bot. Gard. 4: 228. 1906. *Vernonia pallens* Sch. Bip., Jahresber. Pollichia 18/19: 161. 1861. **TYPE: MEXICO**. sin. loc., *Buren s.n.* (not seen). **NEOTYPE** (designated by Jones 1973: 112): **MEXICO. Mexico.** Pungarancho, dry hill, 1933, *Hinton 3132* (neotype: MEXU; isoneotypes: GH, MO, NY, UC, US).

Critoniopsis pallens (Sch. Bip.) H. Rob., *Vernonia michoacana* McVaugh

Key features. Shrubs 3–4 m tall; leaf blades 5–12 × 1.5–5 cm, surfaces nearly concolorous; capitula 1-flowered; cypselae sericeous.

Distribution and representative collections. Mexico (Guerrero, Jalisco, México, Michoacán, Morelos): *Matuda 25973* (MEXU, NY); *Matuda 30473* (NY); *McVaugh 22668* (GA, MICH, NY).

As noted by McVaugh (1972a), this is clearly related to *E. steetzii* as circumscribed here, being basically a smaller leaved variant of it.

EREMOSIS PALMERI (Rose) Gleason, Bull. New York Bot. Gard. 4: 233. 1906. *Vernonia palmeri* Rose, Contr. U.S. Natl. Herb. 1: 101. 1891. **TYPE: MEXICO. Sonora.** Alamos, 16–30 Sep 1890, *Palmer 387* (lectotype sheet designated here: US-49234; isotypes: ARIZ, CAS, GH, K, MEXU, MICH, US-2). There are three sheets of 387 in US, each annotated by Jones as a syntype. Jones (1973) cited US as the lectotype, but it is not clear from either the literature or annotations which sheet was intended as lectotype. One sheet of 387 is from the J.D. Smith herbarium transferred apparently to US post-1891. Of the two USDA sheets in US, the lectotype 49234 has two annotations each clearly in Rose's hand. The other sheets are taken as isotypes (not isolectotypes) in the spirit of earlier versions of the ICBN indicating that only a single type gathering (*Palmer 387*) was cited in the protologue.

Vernonia chacalana S.F. Blake, *Vernonia triflosculosa* subsp. *palmeri* (Rose) S.B. Jones, *Vernonia triflosculosa* var. *palmeri* (Rose) B.L. Turner

Key features. Shrubs 1–2.5 m tall; leaf blades 10–18 × 2–3 cm, surfaces nearly concolorous; capitula 1-flowered; cypselae sericeous.

Distribution and representative collections. Mexico (Chihuahua, Durango, Nayarit, Sinaloa, Sonora): *Gentry 1443* (F, GH, MO, NY); *Goldman 333* (GH, NY, US; type of synonymous *Vernonia chacalana*).

Plants called *V. trifloscula* subsp. *palmeri* by Jones (1973) differ from *E. trifloscula* sensu stricto by their nearly throatless corollas with an elongate tube and shorter corolla lobes deeply cut (albeit asymmetrically so) to near tube and by their double pappus.

EREMOSIS PUGANA (S.B. Jones & Stutts) Pruski, **comb. nov.** *Vernonia pugana* S.B. Jones & Stutts, Brittonia 33: 544. 1981. **TYPE: MEXICO. Jalisco.** 16–22 km S El Chante, 3–6 Feb 1975, *McVaugh 26172* (holotype: MICH; isotypes: IEB, MEXU, MICH, TEX).

Critoniopsis pugana (S.B. Jones & Stutts) H. Rob.

Key features. Scandent shrubs with branches to 10 m long; leaf blades 8–10 × 3.5–4.5 cm, surfaces nearly concolorous; capitula 6–8-flowered; cypselae glandular, never densely setiferous.

Distribution and representative collection. Mexico (Jalisco); known only from the type collection.

By non-setiferous albeit glandular cypselae, *E. pugana* is similar to *E. heydeana* on one hand, but on the other hand seems similar to *E. villaregalis*, as noted by Turner (2007).

EREMOSIS PURPURASCENS (Sch. Bip.) Gleason, Bull. New York Bot. Gard. 4: 233. 1906. = **Eremosis tarchonanthifolia** (DC.) Gleason

EREMOSIS SALICIFOLIA (DC.) Gleason, Bull. New York Bot. Gard. 4: 231. 1906. = **Eremosis corymbosa** (Mill.) Pruski

EREMOSIS SHANNONII (J.M. Coult.) Gleason. **Type, distribution, and representative collections**. Chiapas (Mexico) and Guatemala; see species #6 above.

EREMOSIS SOLORZANOANA (Rzed. & Calderón) Pruski, **comb. nov.** *Vernonia solorzanoana* Rzed. & Calderón, Acta Bot. Mex. 32: 7. 1995. **TYPE: MEXICO. Michoacán**. San José de las Torres, 29 Mar 1987, *Rzedowski 42903* (holotype: IEB; isotypes: CAS, MEXU, MICH, TEX).

Critoniopsis solorzanoana (Rzed. & Calderón) H. Rob.

Key features. Small trees; leaves petiolate, blades 10–15 × 4–5 cm, moderately pubescent; capitula 1-flowered; cypselae sericeous.

Distribution and representative collection. Mexico (Michoacán): known only from the type collection.

Turner (2007: 69) treated pubescent-leaved *E. solorzanoana* in synonymy with admittedly similar subglabrous-leaved *E. baadii*, but Rzedowski and Calderón de Rzedowski (1995a) and Turner (2007: 60, 129) recognized *E. solorzanoana* as distinct. Here by leaf pubescence features of the scanty material I have seen, I recognize *E. solorzanoana* as distinct from each *E. baadii* and newly redefined *E. steetzii*. Rzedowski and Calderón de Rzedowski (1995b: 8) provided an excellent line drawing (as *Vernonia*) of *E. solorzanoana*.

EREMOSIS STANDLEYI (S.F. Blake) Pruski. **Type, distribution, and representative collections**. Central America; see species #7 above.

EREMOSIS STEETZII (Sch. Bip.) Gleason, Bull. New York Bot. Gard. 4: 230. 1906. *Vernonia steetzii* Sch. Bip. in Seemann, Bot. Voy. Herald 297. 1856. **TYPE: MEXICO.** Sierra Madre, 1848–1850, *Seemann 1997* (holotype: P-SCH-BIP; isotype: K as *1997 bis*). Jones (1973) cited the specimen from K as holotype, but it is clear from the protologue of the species on the left (sinistrum) specimens and the variety (here treated in synonymy with *E. foliosa*) on the right (dextrum) that Schultz Bipontinus was referring to a sheet in his personal herbarium as holotype, now cut and mounted on individual sheets in P; K is an isotype.

Cacalia steetzii (Sch. Bip.) Kuntze, ?*Critoniopsis macphersonii* (S.B. Jones & Stutts) H. Rob., ?*Vernonia macphersonii* S.B. Jones & Stutts

Key features. Shrubs 1–2 m tall; leaves relatively short-petiolate, blades relatively long and broad, mostly 8–11 × 4–6 cm, surfaces nearly concolorous, subglabrous; capitula 1-flowered; cypselae sericeous.

Distribution and representative collection. Mexico (Jalisco): *McVaugh 26442* (MEXU, MICH, type of possibly synonymous *Vernonia macphersonii*). [Distribution of *E. steetzii* northward to Durango, San Luis Potosí, Zacatecas as given in Rzedowski and Calderón de Rzedowski (1995a) seems to mostly be in reference to material I would determine as *E. foliosa*].

This relatively large-leaved species is circumscribed here as in Blake et al. (1926). Although Jones (1973), Robinson (1999a), and Turner (2007) treated *E. steetzii* as conspecific with *E. aristifera* and *E. foliosa*, the two relatively small-leaved species are each treated here as distinct. Also similar to *E. steetzii* is relatively long-leaved and long-petiolate *E. baadii*, here recognized more or less as in Jones (1973), Robinson (1993, 1999a), and Turner (2007). Conversely, although Jones and Stutts (1981), Robinson (1993, 1999a), and Turner (2007) recognized *V. macphersonii* as distinct, I am unsure of its identity and have seen no authentic material of it. *Vernonia macphersonii* is envisioned as a short-petiolate and subglabrous relatively large-leaved non-transferred-to-*Eremosis* possible variant of *E. steetzii*. The voucher documenting the report by Jones (1973) of $2n = 36$ in *E. steetzii* has been redetermined here as *E. aristifera*.

EREMOSIS STEETZII var. *CALLILEPIS* (Sch. Bip.) Gleason, Bull. New York Bot. Gard. 4: 231. 1906. = **Eremosis foliosa** (Benth.) Gleason

EREMOSIS TARCHONANTHIFOLIA (DC.) Gleason, Bull. New York Bot. Gard. 4: 230. 1906. *Monosis tarchonanthifolia* DC., Prodr. 5: 77. 1836. **TYPE: MEXICO. Oaxaca**. sin. loc., 1827–1832, *Karwinski s.n.* (holotype: M, as Macbride neg. 20602; isotype: G-DC, as IDC microfiche 800 781.I.6).

Cacalia tarchonanthifolia (DC.) Kuntze, *Critoniopsis tarchonanthifolia* (DC.) H. Rob., *Eremosis purpurascens* (Sch. Bip.) Gleason, *Oliganthes karwinskii* Sch. Bip., *Vernonia purpurascens* Sch. Bip., *Vernonia tarchonanthifolia* (DC.) Sch. Bip.

Key features. Shrubs or trees to 6 m tall; leaf blades 5–11 × 2–3 cm, surfaces obviously discolorous, tomentose abaxially; capitula 2–3(–5)-flowered; cypselae sericeous.

Distribution and representative collections. Mexico (Oaxaca): *Karwinski s.n.* (P, US; type of synonymous *Vernonia purpurascens*); *Pringle 6166* (MICH, MO); *Smith 314* (MEXU, MO).

EREMOSIS THOMASII (H. Rob.) Pruski. **Type, distribution, and representative collection**. Honduras; see species #8 above.

EREMOSIS TOMENTOSA (Lex.) Gleason, Bull. New York Bot. Gard. 4: 229. 1906. *Turpinia tomentosa* Lex., Nov. Veg. Descr. 1: 24. 1824, non *Vernonia tomentosa* (Walter) Elliott. **TYPE: MEXICO. Michoacán**. Prope Vallisoletum, fl. Jan., *Lexarza s.n* (holotype: MA?; possible isotype: NY). The NY sheet is dated from the 1800s and is a possible Lexarza collection or perhaps that of the contemporary La Llave or Sessé and Mociño. The identity of this species does not seem to be in doubt, thus although the basionym is the type of the synonymous genus *Turpinia*, there seems to be no pressing need either nomenclaturally or taxonomically to designate the mostly corolla-less NY sheet as either lectotype or neotype. Figure 12.

Cacalia monosis (Sch. Bip.) Kuntze, *Cacalia paniculata* (DC.) Kuntze, *Cacalia tomentosa* (Lex.) Kuntze, *Critoniopsis tomentosa* (Lex.) H. Rob., *Fulcaldea tomentosa* (Lex.) Less., *Monosis tomentosa* (Lex.) DC., *Vernonia monosis* Sch. Bip. 1847 (nom. nov. for *Turpinia tomentosa* Lex.; non *Vernonia monosis* Benth. ex C.B. Clarke 1873, nom. nov. for *Monosis wightiana* DC.), *Vernonia paniculata* DC.

Key features. Shrubs 1–3 m tall; leaf blades 6–13 × 2.5–7(–9) cm, surfaces obviously discolorous, tomentose abaxially; capitula 1(–2)-flowered; cypselae sericeous. $2n = 72$ (Jones 1973), tetraploid.

Distribution and representative collections. Mexico (centered in Guanajuato, Jalisco, México, Michoacán, Oaxaca, Querétaro): *Andrieux 270* (G-DC-2, as IDC microfiche 800 763.III.8 and 764.I.1, K; type of synonymous *Vernonia paniculata*); *Delgado et al. 643* (MO); *Jones & Chapman 22396* (GA, MO); *Liebmann 8700 (51)* (C, K, US); *Martínez 2012* (CHAPA, MEXU); *Pringle 2439* (F, MO, NY, US); *Purpus 145* (MO); *Rzedowski 25348* (ENCB, MICH); *Ventura & López 6449* (IEB, MO).

Blake et al. (1926) used the name *V. monosis*, but Jones (1973), McVaugh (1984), Rzedowski and Calderón de Rzedowski (1995a), and Turner (2007) used *V. paniculata* for this species. The historic NY sheet (Fig. 12) is a small-leaved top-snatch specimen, but is identifiable with *E. tomentosa*. Argüelles et al. (1991: 70) reported it in Queretaro as both *V. monosis* and *V. paniculata*. In Flora del Valle de Tehuacán-Cuicatlán, Redonda-Martínez and Villaseñor-Ríos (2009: 10) provided an fine illustration (as *Critoniopsis*) of *E. tomentosa*. Jones (1973) cited uniflorous *Hinton 3108* (US) as *V. paniculata*. But, the MO sheet of 3108 has a strange membranous low sheath at the base of the pappus, which has been seen also on rare occasions in other species of *Eremosis*. The strange pappus sheath are anomalies, and are not accorded taxonomic significance.

EREMOSIS TRIFLOSCULOSA (Kunth) Gleason. **Type, distribution, and representative collections**. Mexico and Central America; see species #9 above.

EREMOSIS VILLAREGALIS (Carvajal) Pruski, **comb. nov.** *Vernonia villaregalis* Carvajal, Phytologia 49: 193. Oct. 1981. **TYPE: MEXICO. Jalisco.** Tecolotán, 24 Jan 1981, *Carvajal 3296* (holotype: IBUG).

Critoniopsis tequilana (S.B. Jones & Stutts) H. Rob., *Critoniopsis villaregalis* (Carvajal) H. Rob., *Vernonia tequilana* S.B. Jones & Stutts (Dec. 1981).

Key features. Trees 4–6 m tall; leaf blades 6–10(–15) × 2–3(–6) cm, surfaces somewhat discolorous, moderately canescent but not densely tomentose abaxially; capitula 6–8-flowered; cypselae sericeous.

Distribution and representative collection. Mexico (Jalisco, Michoacán): *Villarreal 6110* (IBUG, MICH; type of synonymous *Vernonia tequilana*).

Excluded species.

Vernonia autumnalis McVaugh, Contr. Univ. Michigan Herb. 9: 477. 1972. *Critoniopsis autumnalis* (McVaugh) H. Rob., Proc. Biol. Soc. Washington 106: 609. 1993. The Composite was described from Jalisco, Mexico by McVaugh (1972a) as the only herbaceous member of *Vernonia* sect. *Eremosis*, but was excluded by Jones (1973) to *Vernonia* sect. *Lepidaploa*. Jones (1979b) reported the base chromosome number as $x = 17$. Turner (2007) treated *V. autumnalis* within ***Vernonia* sect. *Vernonia***. I have examined no material.

Vernonia cordata Kunth, Nov. Gen. Sp. (folio ed.) 4: 31. 1820 [1818]. = ***Vernonanthura cordata*** (Kunth) H. Rob., Phytologia 73: 70. 1992. Turner (2007: 77) said "it is probable that the species belongs to the section *Eremosis*" but it proves to be a *Vernonanthura*.

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FIRST RECORDS OF *CALATHEA VINOSA* (MARANTACEAE) AND *DRACONTIUM PITTIERI* (ARACEAE) FROM PANAMA

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ABSTRACT

Calathea vinosa and *Dracontium pittieri* are reported from Panama (Reserva Natural Privada Audubon-El Chorogo). *Calathea vinosa* is the second species of *Calathea* from Panama with hook-like hairs in the undersurface of the leaf. In Panamá, *D. pittieri* is similar to *D. spruceanum* in size and coloring of the inflorescence and in peduncle length.

Forty-nine (49) species of *Calathea* are recognized from Panama (forty-seven (47) in Kennedy 2012, one (1) in Kennedy 2014 and one (1) in Kennedy & Flores 2015) and three (3) *Dracontium* species (Zhu & Croat 2004). Here we report one more species for each genus, both discovered in the Reserva Natural Privada Audubon-El Chorogo. The El Chorogo forest extends for approximately 10 km in a narrow strip on the Burica Peninsula along the Panamanian side of the border with Costa Rica. It is in an isolated hilly area (elevation 150 to 689 masl) and contains the largest remnant (800 ha) of the forests that once covered all the lowlands of the Pacific slope in extreme western Panama (Angehr 2003) (Figure 1).

Calathea vinosa H. Kenn.

Voucher: **Panamá**. **Provincia de Chiriquí**. Distrito de Barú, Corregimiento de Puerto Armuelles, Reserva Natural Privada Audubon-El Chorogo, N8° 17' 29.1" W82° 59' 46.7", 582 msnm, 30 Abr 2016, (fl), *Flores et. al. 3823 RF* (PMA, SCZ). Figure 2.

Calathea vinosa is distinct from other Panamanian and Costa Rican Marantaceae (Kennedy 1973) in its dark red-purple underleaf, pulvinus, petiole, and stem, leaf blade undersurface covered with retrorsely barbed, hook-like hairs, and its appressed-pilose, cream to faint greenish coriaceous recurved bracts. It is the second *Calathea* species from Panama with hook-like hairs on the undersurface of the leaf. The other species is *C. gymnocarpa* H. Kenn., which differs from *C. vinosa* in its green pulvini and inflorescence with thin membranaceous bracts that melt during fruiting (Kennedy 2003).

Calathea vinosa was previously known only from Costa Rica. In Panama, it was always seen in understory shade within a ture wet forest. Flowering in Panama March-April.

Dracontium pittieri Engler

Voucher: **Panamá. Prov. de Chiriquí**. Distrito de Barú, Corregimiento de Puerto Armuelles, Reserva Natural Privada Audubon-El Chorogo, N8° 17' 26.4" W82° 59' 52.4", 547 msnm, 1 Mar 2016, *Flores et al.* ***3854*** *RF* (fl.) (PMA); *Flores et al.* ***3853*** *RF* (fr.) (PMA, SCZ). Figure 3.

Dracontium pittieri is characterized by leaves solitary; blade of 1–2 m diameter; petioles 1.8–4 m long above ground with protuberances, dark green or brownish green blotched and forming a reptilian pattern; spathe 30–70 cm, inner surface semiglossy, maroon or red-purple, with whitish area obvious (5–10–17 cm high, 1.5 times longer than spadix, outer surface maroon matte; inflorescence with spadix exposed, sessile, cylindrical, brown-purple; infructescence with spadix 10–20 cm long; berries 2-seeded, young berries medium green; seeds reniform or triangular. Also it has the longest peduncle (1.5–2.5 m) within the genus *Dracontium* (Zhu & Croat 2004).

In Panama, *Dracontium pittieri* is similar to *D. spruceanum* (Schott) G.H. Zhu in size and coloring of the inflorescence and length of the peduncle but differs in its cymbiform spathe and in having laminar tissue in the axes of the three divisions of the leaf decurrent up to near the petiole apex (Grayum 2003; Zhu & Croat 2004).

We collected the inflorescence in hours of the afternoon. In the night there was a fetid odor in the campsite, similar to animal decomposition, and in the morning of the next day, the inflorescence was full of flies. Zhu and Croat (2004) explained that the spathe of *Dracontium* gives off fetid odor, reminiscent of rotten meat. Time and duration of the odor emission differs between species and the most similar is *D. croatii* G.H. Zhu, which smells intensely from afternoon to evening. The pollinators of *Dracontium* remain unknown (Zhu & Croat 2004), although Croat (1975) mentioned that *Dracontium* probably has a fly-pollination syndrome (sapromyophily) because of trap-like nature of the spathe of some species and the foul scent during anthesis, which is also typical of other fly-pollinated species in the Araceae.

Dracontium pittieri previously was considered endemic to the Pacific slope in the province of Puntarenas, Costa Rica. It had not been collected in adjacent Panama (Zhu & Croat 2004) until now. It was collected in the Audubon-El Chorogo Private Nature Reserve on the edge of a creek in a very humid place, in an area more or less exposed to the light.

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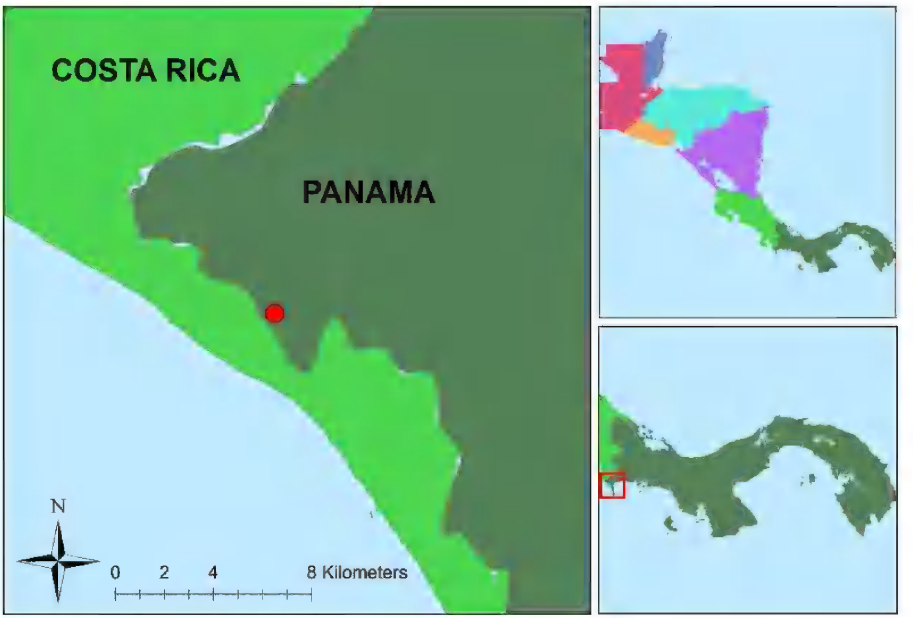

Figure 1. Location of the Reserva Natural Privada Audubon-El Chorogo in Panama. The collections of *Calathea vinosa* and *Dracontium pittieri* were made in the Reserve.

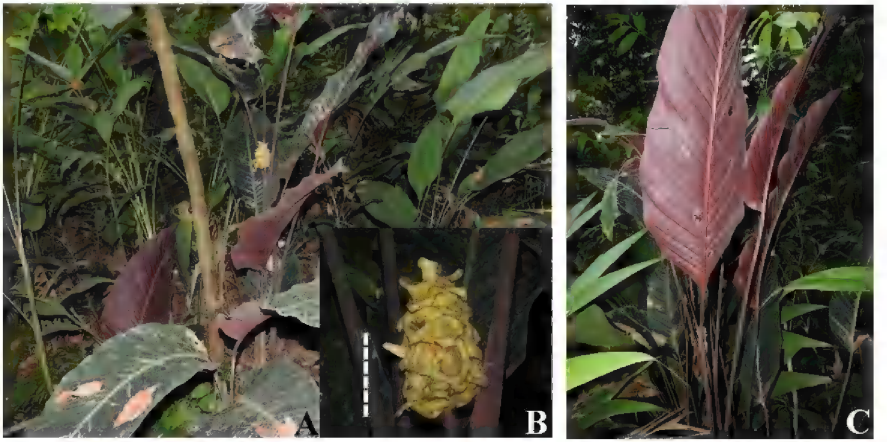

Figure 2. *Calathea vinosa*. (A) Habit. (B) Inflorescence, showing coriaceous, recurved bracts (scale= 6.5 cm). (C) Underleaf, pulvinus, and petiole.

Figure 3. *Dracontium pittieri* . (A) Habit. (B) Inflorescence (scale= 11 cm). (C) Infructescence (scale= 15 cm).

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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 20. EUDICOTS: SOLANACEAE TO ZYGOPHYLLACEAE

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ABSTRACT

A floristic account is provided for Solanaceae, Talinaceae, Tamaricaceae, Urticaceae, Verbenaceae, and Zygophyllaceae as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in southwestern Arizona—the heart of the Sonoran Desert. This account includes 40 taxa, of which about 10 taxa are represented by fossil specimens from packrat middens. This is the twentieth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium: <http//cals.arizona.edu/herbarium/content/flora-sw-arizona>.

Six eudicot families are included in this contribution (Table 1): Solanaceae (9 genera, 21 species), Talinaceae (1 species), Tamaricaceae (1 genus, 2 species), Urticaceae (2 genera, 2 species), Verbenaceae (4 genera, 7 species), and Zygophyllaceae (4 genera, 7 species). The flora area covers 5141 km^2 (1985 mi^2) of contiguous protected areas in the heart of the Sonoran Desert (Figure 1).

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). These contributions are also posted open access on the website of the University of Arizona Herbarium (ARIZ). Family designations follow APG III and 1V (Angiosperm Phylogeny Group 2009, 2016; also see Stevens 2012). Non-native taxa established in the flora area are marked with an asterisk (*) and non-natives not established in the flora area are marked with double asterisks (**). Present-day taxa also represented by fossil specimens are indicated with a dagger symbol (†) and the one species no longer present in the flora is marked with two dagger symbols (††).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2016). All photos and scans are by Sue Rutman unless otherwise stated and botanical illustrations are by Lucretia Breazeale Hamilton (1908–1986). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

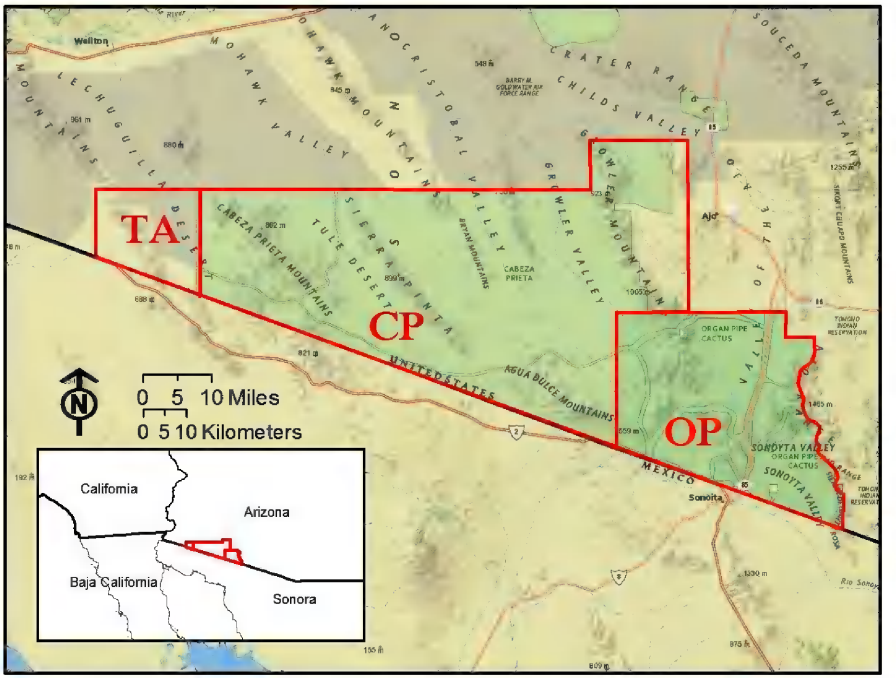

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness. Map by Jim Malusa.

Table 1. Local distributions and growth forms of Solanaceae, Talinaceae, Tamaricaceae, Urticaceae, Verbenaceae, and Zygophyllaceae. † = Modern species also represented by a fossil; †† = fossil taxon no longer present; * = non-natives taxa; ** = non-native species not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = Summer/warm-season ephemerals; WI = winter-spring/cool-season ephemerals; AP = facultative annuals or perennials; PR = perennials.

Taxon	Region			Growth Form				
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals			Facultative annual or perennial	Perennial
				Summer	Winter	Non-seasonal		
SOLANACEAE								
Calibrachoa parviflora	OP					NS		
Capsicum annuum	OP							PR
Chamaesaracha arida		CP	TA					PR
Datura discolor	OP	CP	TA			NS		
†† *Datura wrightii*	(OP)							(PR)
Lycium andersonii	OP	CP	TA					PR
Lycium berlandieri	OP	CP						PR
† *Lycium* cf. *berlandieri*	(OP)							PR
Lycium californicum	OP	CP						PR

Lycium exsertum	OP							PR
Lycium fremontii	OP	CP	TA					PR
†*Lycium macrodon*	OP	CP	TA					PR
Lycium parishii	OP	CP	TA					PR
†*Lycium* sp./spp.	(OP)		(TA)					PR
Nicotiana clevelandii	OP	CP	TA		WI			
******Nicotiana glauca*	(OP)							PR
†*Nicotiana obtusifolia*	OP	CP	TA					PR
*****Physalis acutifolia*	OP	CP?		SU				
Physalis crassifolia	OP	CP	TA					PR
†*Physalis* sp./spp.	(OP)		(TA)					
Quincula lobata	OP							PR
*****Solanum americanum*	OP						AP	
†*Solanum hindsianum*	OP		(†TA)					PR
Solanum nigrescens	OP							PR
Solanum umbelliferum	OP							PR
TALINACEAE								
Talinum paniculatum	OP							PR
TAMARICACEAE								
******Tamarix aphylla*	(OP)	(CP)						PR
*****Tamarix chinensis*	OP	CP						PR
URTICACEAE								
†*Parietaria hespera*	OP	CP	TA		WI			
Urtica gracilenta	OP			SU				
VERBENACEAE								
Aloysia wrightii	OP	CP						PR
Glandularia gooddingii	OP	CP					AP	
Glandularia latilobata	OP						AP	
†*Glandularia* sp./spp.	(OP)		(TA)				?	
******Lantana camara*	(OP)							PR
Verbena bracteata		CP			WI			
Verbena menthifolia	OP	CP					AP	
Verbena xylopoda	OP							PR
ZYGOPHYLLACEAE								
Fagonia laevis		CP	TA					PR
Fagonia longipes	OP	CP						PR
Fagonia pachyacantha		CP	TA					PR
Kallstroemia californica	OP	CP	TA	SU				
Kallstroemia grandiflora	OP	CP		SU				
†*Kallstroemia* sp./spp.	(OP)			SU				
†*Larrea tridentata*	OP	CP	TA					PR
*****Tribulus terrestris*		CP		SU				

SOLANACEAE – Nightshade or Potato Family

Herbs and shrubs in the flora area (some vines and trees elsewhere). Leaves alternate (often fascicled on short shoots) or sometimes subopposite; stipules none. Flowers bisexual or sometimes unisexual, 4- or 5-merous, and often showy. Calyx 4- or 5-lobed, and persistent. Corollas 4- or 5-lobed, mostly radially symmetrical (those in the flora area), mostly plicate in bud. Stamens 4 or 5, the filament bases fused to the corolla. Ovary superior, the style 1, the stigma 2-lobed or capitate. Fruit a berry (becoming indurate in *Lycium macrodon*) or a capsule; seeds few to many.

Worldwide, mostly tropical and temperate, greatest diversity in Central and South America; 94 genera, 2950 species.

1. Herbage glabrous, or with simple or stellate hairs; anthers opening with a terminal pore (longitudinal slit in *S. umbelliferum*) and longer than the filaments; fruits of berries…….. **Solanum**
1. Hairs, if present, not stellate; anthers opening longitudinally and shorter than the filaments (or nearly as long as the filaments in *Capsicum*); fruits of berries or capsules.

2. Woody shrubs or if not especially woody then more than 1.5 m tall.

3. Widespread hardwood shrubs, the twigs thorn-tipped or bearing spines; leaves less than 5 cm long, sessile or short-petioled……... **Lycium**
3. Scarce in the flora area, roadsides; unarmed and scarcely woody; leaves more than 7 cm long, the petiole more than 3 cm long……..…….. **Nicotiana glauca**

2. Plants herbaceous, mostly less than 1–1.5 m tall, annuals or herbaceous perennials, or sometimes scarcely woody at the base.

4. Plants prostrate and rooting at nodes; leaves 0.5–1.5 (2) cm long, nearly sessile to short petioled (petiole much shorter than the blade)…….... **Calibrachoa**
4. Plants not both prostrate and rooting at nodes; leaves 2.5–15 cm long, or if less than 2.5 cm in length then the petiole about as long as or longer than the blade.

5. Corollas more than 10 cm long; fruits prickly-spinescent……..…… **Datura**
5. Corollas less than 4 cm long; fruits not prickly-spinescent.

6. Corollas tubular; fruit a capsule (dry)……..……... **Nicotiana**
6. Corollas as broad as or broader than long or deep (not tubular); fruit a berry (fleshy).

7. Fruiting calyx not inflated, not growing around fruit; fruits bright red when ripe. …… **Capsicum**
7. Fruiting calyx enlarging to partially or fully surround fruit; fruits green.

8. Fruiting calyx partially growing around and tightly enclosing the berry; corollas greenish yellow with a woolly pad at center…….. **Chamaesaracha**
8. Fruiting calyx completely and loosely growing around the berry like a bag; corollas various colors, without a woolly pad.

9. Roots not thickened; stems or branches held aloft; corollas yellow or white; herbage with short, straight, glandular hairs about the same color as the herbage…….. **Physalis**
9. Perennials from a thickened root; stems spreading to decumbent; corollas lavender; herbage scurfy with rounded white "hairs" (vesicular trichomes) especially on young growth and young calyces…….. **Quincula**

Calibrachoa

Annual and perennial herbs. South America and one also in North America; 25 species. A genus segregated from *Petunia*. Horticultural selections of *Calibrachoa* and *Calibrachoa–Petunia* hybrids, known as ×*Petchoa*, with brightly-colored flowers, are grown as garden plants.

Calibrachoa parviflora (de Jussieu) D'Arcy
[*Petunia parviflora* de Jussieu]
Small-flowered petunia. Figure 2.

Ephemerals, probably non-seasonal, and glandular-viscid. Stems spreading-prostrate, rooting at nodes, reaching 50 cm long. Leaves alternate, 5–20 mm long, mostly linear to spatulate or

oblanceolate, often semi-succulent; margins entire or nearly so. Calyx lobed halfway or more, the lobes much longer than the tube, and about as long as the corolla. Corollas funnelform to cup-shaped, 8 mm wide, the tube white or yellowish, the corolla limb and lobes purple. Fertile stamens 4, plus a sterile filament. Fruit a capsule opening apically; seeds numerous, minute, 0.5 mm long, chunky, brown, conspicuously reticulate with minute iridescent "windows" or facets.

In the flora area known only from Quitobaquito where about a half dozen plants were found in 1988 on moist soil of the alkaline flat just west of the pond, but these plants were not present the following year. The nearest records are along the banks of the Colorado River at Yuma and the Buenos Aires National Wildlife Refuge.

Southern United States to South America, and introduced and weedy elsewhere; perhaps not native outside of South America.

OP: Quitobaquito, rare on barren ground on alkaline flat, 6 Apr 1988, *Felger 88-317.*

Figure 2. *Calibrachoa parviflora.* Salero Ranch, Santa Cruz Co., photos by Sue Carnahan: (A) Cattle tank near ranch headquarters, 26 Mar 2014; (B) Cattle tank in unit 4, 30 May 2013.

Capsicum

Annual and perennial herbs and small shrubs. Americas, mostly tropical and subtropical; 25 species. Includes the diverse cultivated chiles.

Capsicum annuum Linnaeus var. **glabriusculum** (Dunal) Heiser & Pickersgill
[*C. indicum* Dierbach forma *aviculare* Dierbach. *C. annuum* var. *aviculare* (Dierbach) D'Arcy & Eshbaugh (nom. illegit.)]
Chiltepin, bird-pepper; *chiltepín*; a'al ko'okol. Figure 3.

Slender-stemmed, much-branched bushes, perennial and scarcely woody at the base; glabrate to sparsely puberulent. Leaves with slender petioles, the blades thin and ovate to lanceolate-ovate, 2–6 cm long, the tip acute, the margins entire. Flowers on slender pedicels elongating in fruit; calyx minutely 5-toothed; corollas white, 7–10 mm wide, nearly rotate and broadly 5-toothed with a very short tube. Anthers opening by longitudinal, full-length slits, the filaments as long as or longer than the anthers. Berries rounded to ellipsoid, 8 mm in diameter, red when ripe, ripening at least in late summer and fall, and often persisting through winter or early spring; multiple-seeded with pale

yellowish brown seeds 2.5 mm wide.

Scattered and locally in canyons and steep slopes in the Ajo Mountains.

This is the famous, fiery-hot wild chile ranging from southern Arizona and Texas to South America. The westernmost limit is in the Ajo Mountains and it is more common eastward in the Tohono O'odham region and to the southeast in Sonora.

OP: Alamo Canyon, 14 Sep 1941, *Goodding 310-41* (ASU). Boulder Canyon: Side drainage to the S, on steep N-facing shaded slope, 4 ft high, growing up through *Simmondsia*, 15 Jan 1989, *Wilson 207*; N-facing, growing along W wall of very steep side drainage with *Rhamnus ilicifolia* and *Prosopis velutina*, one plant, *Tewksbury 11 Sep 2004*.

Figure 3. *Capsicum annuum* var. *glabriusculum*. Plant grown from seed from Native Seed/Search, from Tumacacori Chiltepine Preserve, Santa Cruz Co., 25 Aug 2015, photos by Jim Verrier.

Chamaesaracha

Herbaceous perennials. Mexico and southwestern United States; 8 species.

Chamaesaracha arida Henrickson
[*C. felgeri* B.L. Turner, Phytologia 97(3): 232–233, Fig. 1, Map 7, 2015.]
False nightshade. Figure 4.

Herbaceous perennials from deeply buried roots, rhizomatous, and the stems often partially buried. The above-ground portion is frost sensitive. Stems ascending to spreading, 5–55 cm long. Herbage with branched and forked hairs with thick, short, white cells; new growth densely pubescent, older herbage often less densely to sparsely pubescent. Leaves alternate and opposite (even on the same stem), (2.5) 4–9 cm long, mostly narrowly elliptic, sessile to petioled, the margins mostly pinnately lobed or sometimes wavy. Flowers 1 or 2 in axils, on slender pedicels (1) 2–6 cm long. Calyx 5-lobed, moderately enlarging and partially or mostly covering the berry (not inflated as in *Physalis*). Corollas 1.5–2.5 cm wide, rotate or circular in outline (with very short lobes), cream-yellow to white, with darker, thicker, plicae (pleats) forming a star-shaped pattern and woolly pads alternating with the filament bases. Anthers yellow, opening longitudinally. Berries globose, 6–8 mm wide, usually whitish and becoming rather dry, few-seeded and bearing seeds only near the base. Growing and flowering during warmer times of the year depending on soil moisture.

Locally common in low-lying silty soils of playas, sand flats, valleys, and low dunes along the southern part of Cabeza Prieta and the Lechuguilla Valley.

Arizona to Utah, Colorado, New Mexico and west Texas, and northern Mexico from Sonora eastward and southward in the Chihuahuan Desert Region.

Figure 4. *Chamaesaracha arida*. Salero Ranch, 8 miles E of Tubac, Santa Cruz Co., 13 Apr 2013, photos by Sue Carnahan. [ID corrected 10 Aug 2016]

Three botanists have each provided different taxonomies for *Chamaesaracha*. The most conservative is by Averett (1973, 2010), in which he recognized a widespread *C. coronopus*. Henrickson (2009) segregated western populations of *C. coronopus* as *C. arida*, and noted that the type material of C. *coronopus* is glabrous. Turner (2015) opted for narrower interpretations, restricting *C. coronopus* to southern Texas and adjacent northeastern Mexico. He mapped *C. arida* in Arizona, including Yuma County, to Utah, Colorado, and Texas and much of northern Mexico. Turner (2015: 232–233) named *C. felgeri* as a narrow endemic that is "apparently adapted to deep sandy soils and appears restricted to southern Yuma Co. (and perhaps closely adjacent Mexico)" and "resembles *C. arida*, but differs in having larger mid-stem leaves (ca. 7–12 cm long vs. 3–5 cm), longer hairs on both stems and calyx (ca. 2–3 mm vs. 0.5–1.0 mm), and larger, more expanded, corollas (2–3 cm across vs. 1–2 cm)." Turner cited the following specimens for *C. felgeri*: *Felger 92-26*, *92-626*, *01-548*, and *04-63* (holotype). Some plants on the dunes benefit from the captured water in the sands below and indeed are larger with larger leaves and larger flowers than other populations. Other plants from Yuma County and elsewhere have smaller leaves and flowers and some on the dunes produced in years of scant rainfall also have relatively small leaves and flowers (James Henrickson, pers. comm. 2016).

Chamaesaracha felgeri joins the ranks of other endemic or quasi-endemic taxa adapted and restricted to dune and windblown sand habitats of southwestern Arizona and adjacent or nearby areas in northwestern Sonora, southeastern California, and northeastern Baja California. These plants show varying morphological distinctions that may or may not be sufficiently or genetically differentiated to warrant taxonomic recognition. *Dalea mollissima, Euphorbia platysperma, Heterotheca thiniicola*, and *Stephanomeria schottii* are clearly endemic at the species level. Others, such as *Argythamnia serrata* sensu stricto, *Chamaesaracha felgeri*, *Croton wigginsii* sensu stricto, *Larrea tridentata* var. *arenaria*, *Palafoxia arida* var. *gigantea*, and *Sphaeralcea orcuttii,* offer fertile ground for further investigation (e.g., Felger 2000; Felger et al. 2015a; Felger & Rutman 2015a).

CP: Pinacate Flats, *Hardy & Goodding 3 Dec 1935.* Pinacate Plateau, Camino del Diablo, 28 Oct 1937, *Gentry 3507* (DES). NE edge of Las Playas, Tule Desert, 15 Apr 1964, *Niles 355.* E edge of Las Playas, 700 ft, *Simmons 13 Sep 1964.* Camino del Diablo, 10.3 mi WSW of Papago Well, creosote flat, corolla yellowish, frequent, 12 Mar 1983, *Daniel 1683* (ASU). Dunes N of Camino del Diablo, 6 mi W of O'Neils grave, flowers white, 13 Mar 1983, *Eiber 37.* Playa west of O'Neil Hills, *Harlan 20 Mar 1983.* W of Pinacate lava flow, common in silty depressions, sandy plains, 29 Mar 1985, *McLaughlin 2989.* Pinta Sands along Camino del Diablo, common on low dunes with extensive populations of spring ephemerals, 780 ft, 1 Feb 1992, *Felger 92-26* (ARIZ, TEX). Lava and sand on Pinacate Lava flow, old sandy streambed, white flowers, 21 Mar 1992, *Harlan 60.* Tule Tank drainage, 23 Mar 1992, *Harlan 115b* (CAB). West Pinta Sands, 780 feet, locally common on low stabilized dunes, *Larrea divaricata, Hilaria rigida, Palafoxia arida, Oenothera avita, O. deltoides*, 16 Jun 1992, *Felger 92-626* (ARIZ, TEX). E Pinta Sands, sand soil, *Larrea divaricata, Prosopis velutina-glandulosa, Hilaria rigida, Opuntia kunzei, Ambrosia deltoidea*, few *Ferocactus wislizeni*, 15 Sep 1992, *Felger 92-763.* W Pinta Sands, sand flats and low, stable dunes, *Prosopis* cf. *glandulosa* var. *torreyana, Larrea divaricata, Stillingia linearifolia*, and ephemerals, 15 Sep 1992, *Felger 92-782.* Pinacate Lava along Camino del Diablo at 2 mi E of W edge of the lava flow, 28 Nov 2001, *Felger 01-548* (ASU, TEX).

TA: Lechuguilla Valley, vicinity Coyote Water in Coyote Wash, wash banks, broad sandy wash, cut about 1 m deep, 975 ft, *Prosopis glandulosa, Acacia greggii, Lycium parishii, L. fremontii, L. macrodon, Encelia farinosa, Ambrosia ambrosioides, Hymenoclea salsola*, dense growth of ephemerals, 25 Oct 2004, *Felger 04-35.* Coyote Wash at Camino del Diablo, bottom of Lechuguilla Valley, SE of Tinajas Atlas, 1010 ft, lowest point on Camino crossing, there is a sheet flow here in the valley bottom but no wash (erosion) has formed, perennials from deep-seated roots, corollas whitish, 25 Oct 2004, *Felger 04-63* (holotype of *C. felgeri*, TEX; isotypes, ARIZ, ASU, MO).

Datura – Jimsonweed

Annuals and herbaceous perennials. New World, tropical to warm temperate, especially Mexico and southwestern United States, adventive in the Old World; 13 species. The plants contain narcotic and poisonous alkaloids.

Datura discolor Bernhardi

Desert datura; *toloache.* Figure 5.

Non-seasonal ephemerals, but frost-sensitive and responding poorly to cooler weather; highly variable in size, 8–60 cm to sometimes more than 100 cm tall. Herbage stinky, glabrate or variously pubescent. Leaves broadly ovate, entire or toothed or pinnately lobed, larger leaves 7–20 cm long, the petioles prominent. Flowers large, solitary, erect, fragrant, nocturnal, and lasting one day. Flowering calyx tubular, ribbed, 7–9.5 cm long, most of the calyx falling away as the fruit develops, leaving the calyx base to form a bract-like skirt 1–1.5 cm wide around the base of the fruit. Corollas 8–17 cm long, white with a purple flush in the throat. Anthers opening longitudinally. Fruits globose, prickly (spinescent) capsules, turning down at maturity, (3.5) 4–5 (7) cm wide including spines. Seeds small, kidney-shaped, and blackish, with a white caruncle.

Widely scattered across the flora area, mostly along washes, also waterholes and canyon bottoms.

Southern Arizona and southeastern California to Baja California Sur and southern Mexico, and the Caribbean. The flowers are the largest of any plant in the Sonoran Desert.

All parts of the plant are poisonous and may cause dizziness, vomiting, dermatitis, permanent mental disorder, and even death. The common English name, Jimsonweed, is derived from Jamestown, Virginia, where British troops were poisoned by eating the foliage. Some Native American names refer to its narcotic effect or sacredness, although various indigenous people treat the plant with considerable respect and caution. Medicinal uses have been widespread, including among the Seris and the Hia-Ced O'odham (Felger & Moser 1985; Felger et al. 1992).

OP: SE of Walls Well, 30 Aug 1945, *Gould 3216.* Dos Lomitas, *Warren 17 Nov 1974.* Aguajita Wash, 13 Sep 1986, *Felger 86-282.*

CP: Papago Well, 27 Oct 1937, *Gentry 3498* (DES). West Pinta Sands, 15 Sep 1992, *Felger 92-778.*

TA: Tinajas Altas, bajada, 19 Mar 1998, *Felger* (observation). Coyote Wash at Camino del Diablo, 25 Oct 2004, *Felger 04-64.*

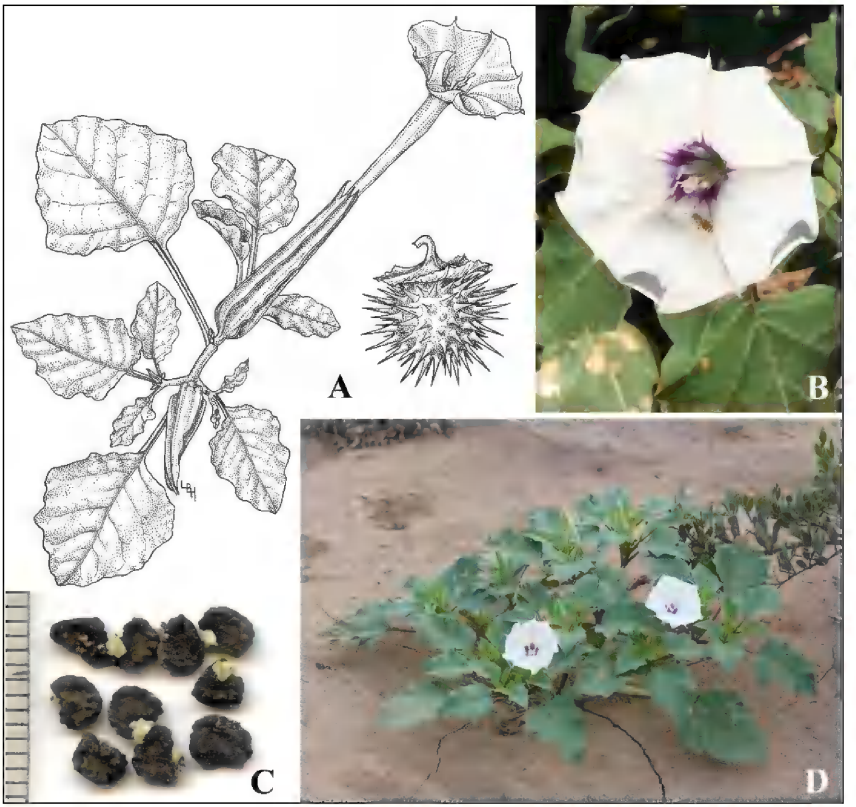

Figure 5. *Datura discolor.* (A) By Lucretia Breazeale Hamilton. (B) Arch Canyon, 16 Sep 2006. (C) Seeds, note the white strophioles, Ajo, 20 Sep 2014. (D) W of Hwy 85 at mile 66, 6 Oct 2012.

††**Datura wrightii** Regel
[*D. meteloides* of authors, not *D. meteloides* Dunal]
Toloache

Large herbaceous perennials with large white flowers. The seeds differ in part from those of *D. discolor* by being larger, more pear shaped, flattened, and bony in texture.

It was in Organ Pipe more than 9000 years ago. The nearest present-day population is in the Baboquivari Mountains. A widespread and often weedy species, southwestern United States and northwestern Mexico.

OP: †Alamo Canyon, seeds, 9570 ybp. Puerto Blanco Mts, seeds, 9070 ybp.

Lycium – Wolfberry, box thorn; *salicieso* (Sonora), *frutilla* (Baja California)

Densely branched, unpleasantly thorny or spinescent shrubs with hard wood and rigid stems (those in the flora area); glabrate or glabrous, or with multicellular glandular and/or non-glandular hairs. Leaves gradually drought deciduous, entire, and semi-succulent, clustered (fascicled) in short shoots, as well as widely spaced on long shoots (primary growth). Flowers borne in the leaf axils, single or in groups of 2–6 per leaf fascicle. Most flowers (4-) 5-merous. Calyx cup-shaped to tubular, (2–4) 5-toothed or lobed. Filaments longer than the anthers, the anthers opening longitudinally. Often flowering in mid-winter to early spring depending on soil moisture, or with sufficient rain some may flower at any time of year. Fruit a berry (fleshy and red or orange) or drupe-like (hard and scarcely fleshy, green or red-orange). Seeds 2–many, usually somewhat flattened.

Worldwide, mostly deserts and warm semi-arid regions, a few in more humid regions, many semi-halophytic; 90 species. The Chinese wolfberry, *L. chinensis*, is cultivated in the East Asia as a leaf vegetable, the goji berry is the fruit of *L. barbarum*, also from China, and a few species are grown in temperate climates as ornamental shrubs.

Identification can be risky or hopeless without flowers or fruits. However, even in dry season you can often find at least a few dried flowers or fruits, allowing identification. *L. exsertum*, and *L. fremontii* have morphologically distinctive male and female/bisexual flowers on separate plants (Miller & Venable 2002; Yeung et al. 2005). The other species in the flora area produce bisexual flowers. The fleshy-fruited species have edible fruits, although only *L. fremontii* seems to have been a significant food plant (Felger 2007; Felger & Moser 1985; Hodgson 2001). Chiang and Landrum (2009) provide useful floristic information and distribution maps for Arizona.

1. Corollas whitish, or whitish with a greenish tube; fruits scarcely fleshy or with a thin fleshy pericarp, greenish glaucous or red-orange, 1–4-seeded.

2. Shrubs mostly less than 1 (1.3) m in height; leaves 2.5–20 mm long, at least the short-shoot, fascicled leaves rounded in cross-section and often bead-like; calyx lobes (2 or 3) 4, the corolla lobes 4; fruits not constricted, 2–4 mm long, orange to red-orange when ripe. ..... **Lycium californicum**

2. Shrubs often more than 1.5 m tall; leaves 15–50 cm long, flattened; calyx lobes 5, the corolla lobes 5; fruits constricted near or below middle, 10 mm long, greenish-glaucous even when ripe. ..... **Lycium macrodon**

1. Corollas whitish or lavender; fruits fleshy, orange to red-orange when ripe, several- to many-seeded.

3. Calyx lobes about as long as or longer than the calyx tube (lobes sometimes shorter on some flowers on a shrub).

4. Calyx usually 4- or 5-keeled, the areas (sinuses) between lobes of flowering calyx rounded, the calyx lobes unequal in size, some lobes essentially absent; flowers often highly congested (crowded) on stems..... **Lycium brevipes**

4. Calyx usually not keeled (or not conspicuously so), areas between lobes of flowering calyx narrow, acute, the calyx lobes equal in size; flowers not congested..... **Lycium parishii**

3. Calyx lobes shorter than the tube (sometimes as long as the tube in *L. berlandieri*).

5. Leaves, pedicels, and calyces glandular-hairy; pedicels 4–16 mm long; flowers unisexual, male and female flowers of different sizes and on separate plants.

6. Corollas mostly white, flared above, the tube pubescent inside; male flowers with stamens exserted, the free portion of the filaments very densely hairy below..... **Lycium exsertum**
6. Corollas lavender, tubular, the tube glabrous inside; male flowers with stamens not exserted, the free portion of the filaments glabrous to moderately hairy..... **Lycium fremontii**

5. Plants glabrous; pedicels mostly 1–7 mm long; flowers bisexual.

7. Flowers slender, longer than wide; corolla tube narrow, cylindrical or nearly so, the lobes lavender; filaments sparsely hairy to glabrous at base of free portion..... **Lycium andersonii**
7. Flowers broad, as wide as or wider than long, the corolla tube campanulate (conspicuously expanded above), the corollas (including lobes) whitish; filaments densely hairy at base of free portion..... **Lycium berlandieri**

Lycium andersonii A. Gray var. **andersonii**
[*L. andersonii* var. *deserticola* (C.L. Hitchcock) Jepson]
Desert wolfberry; *salicieso*; s-toa kuavulĭ. Figure 6.

Shrubs, often 1.2–2.5 m tall, the bark tan to grayish and often striate, twigs often thorn-tipped. Leaves glabrous, mostly linear-spatulate, 5–30 × 1.5–4 (6) mm. Pedicels 1–7.5 mm long. Flowers nearly tubular. Calyx tube 1.6–2.6 mm long, the teeth (lobes) 0.4–1.3 mm long and often with minutely ciliate margins (calyx often cleft, forming 2 larger lobes, each with 2 or 3 teeth, the calyx then appearing 2-lipped). Corollas slender, the tube mostly very narrow and nearly tubular, greenish white, 5.5–12.5 mm long when fresh, the lobes 1.4–2.5 mm long, lavender, 4 or 5 (sometimes even on the same plant; the fifth lobe sometimes larger than the others). Stamens about as long as the tube to moderately but conspicuously exserted; basal part of free portion of filaments glabrous or moderately pubescent with short white hairs, the fused portion densely hairy. Fruits often 1 cm long, ovoid, fleshy, bright orange, with multiple seeds, each 1.3–1.5 mm long. Flowering mostly February to April, and also with rains at other seasons.

Common and widespread across the flora area in many habitats including plains, sand or rocky hills, mountains, and especially common along washes and on rocky slopes. The fruits are edible.

Variety *andersonii* occurs through most of the species range: Arizona to Sinaloa, Utah, Nevada, and southern California to Baja California Sur. Three other varieties, only one of which, var. *pubescens* S. Watson, is probably worth recognizing (Felger 2000; Felger & Wilder 2012).

OP: Kino Peak, 18 Mar 1944, *Clark 11418* (ORPI). Dos Lomitas, *Warren 17 Nov 1974* (ORPI). Puerto Blanco loop, 1.3 mi S of junction with Bates Well Road, 7 Jun 1975, *Chiang 662* (ASU). Quitobaquito, 23 Feb 1990, *Felger 90-47.*

CP: Pinacate Plateau, 24 Nov 1934, *Goodding 253G.* Buckhorn Tank, *Monson 22 Dec 1954* (CAB). . 5 mi N of Tule Tank, 2 Feb 1992, *Felger 92-76.* E Pinta Sands, 15 Sep 1992, *Felger 92-756.* Chico Shunie Wash, 2 Feb 2003, *Rutman 2003-31.*

TA: Borrego Canyon, 3 Feb 1990, *Felger* (observation). Arroyo 2 mi SE of Tinajas Altas, 22 Nov 2008, *Felger 08-196.*

Figure 6. *Lycium andersonii* var. *andersonii*. (A) Bonito Well, 12 Mar 2015. (B–D) Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015. Hat Mountain, Sauceda Mts, Maricopa Co.: (E) 20 Aug 2006; (F) 22 Mar 2014. (G) Tubac Foothills Ranch, Santa Cruz Co., 18 Jul 2015, photo by Sue Carnahan.

Lycium berlandieri Dunal var. **longistylum** C.L. Hitchcock
Bachata, salicieso. Figure 7.

Spinescent woody shrubs often 1–2+ m tall, often somewhat sparsely or openly branched. Resembling *L. andersonii* but distinguished in part by smooth and dark reddish-brown bark, pale yellow-white flowers, conspicuously wider (campanulate) corollas, and longer corolla lobes. Leaves mostly 5–30 mm long, linear to spatulate-obovate, glabrous. Flowers solitary or 2 or 3 in fascicles in leaf axils. Pedicels 3–20 mm long. Calyx cup-shaped, 3–5 lobed. Corollas white, constricted above

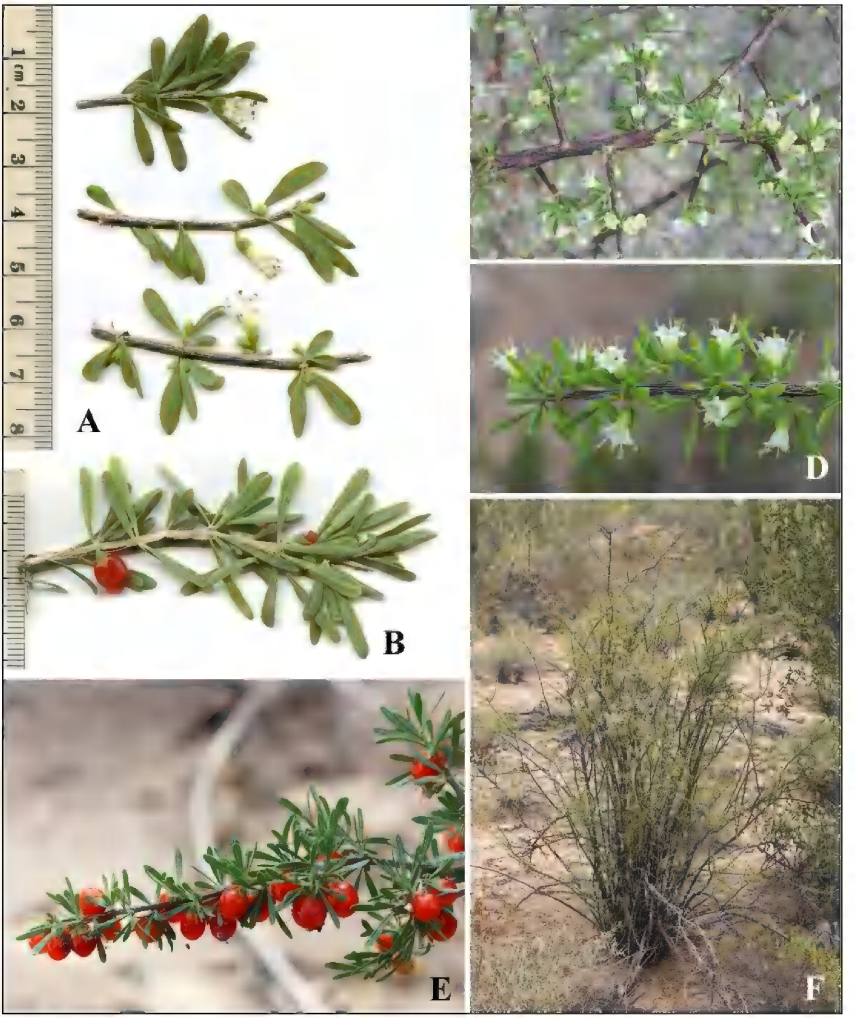

Figure 7. *Lycium berlandieri* var. *longistylum.* Ajo Scenic Loop, Little Ajo Mts: (A) 31 Jul 2014; (B) 23 Aug 2014. (C) Ajo, 5 Sep 2011. (D) Ajo Mountain Drive, 2 Aug 2013. (E) Gunsight Hills, 10 Sep 2013. (F) Senita Basin, 10 May 2010.

the ovary, campanulate, as wide as or wider than long, 4–9 mm long, with 4 or 5 lobes. Stamens shorter than the tube or long-exserted, filaments densely hairy at base of free portion. Fruits globose, 5 mm wide, fleshy and red-orange, edible, and many-seeded. Apparently flowering at various seasons with sufficient soil moisture, at least in March and fall.

Widespread in Organ Pipe and the eastern part of Cabeza Prieta. Rocky slopes and low hills, coarse soils and sometimes in cracks in bedrock, as well as along washes. This or a similar species has been in Organ Pipe for more than 7500 years.

Four varieties in northern Mexico and Arizona to Texas. Variety *longistylum* in southern Arizona and western Sonora.

OP: Ajo Mt Drive 5.1 mi by road NE of Visitor Center, 5 Nov 1977, *Bowers 908.* 1 mi SW of Visitor Center, 13 Sep 1978, *Bowers 1522.* 1.5 mi N of Twin Peaks, Puerto Blanco Mts, 30 Mar 1980, *Stimson 205.* Arch Canyon, *Rutman 14 Aug 1996* (ORPI). †*L.* cf. *berlandieri*: Puerto Blanco Mts, on ridge, twigs, leaves, seeds, modern (30) to 7560 ybp (11 samples).

CP: Christmas Pass, *Van Devender 9 Mar 1980.* Lower end of Agua Dulce Pass, 19 Mar 1987, *Elias 10229.*

Lycium brevipes Bentham var. **brevipes**
[*L. richii* A. Gray]
Salicieso. Figure 8.

Densely branched shrubs to 2+ m tall. Leaves, pedicels, and calyces conspicuously glandular pubescent. Leaves broadly to narrowly spatulate or oblanceolate, 6–40 × 4–8 mm. Flowers and fruits commonly many and crowded at the branch tips. Pedicels 3–5 mm long. Calyx, corolla, and stamens 4- or 5-merous, even on the same branch. Flowers pale lavender, calyx and corolla lobes usually long relative to the tube. Calyx tube and lobes often 4- or 5-keeled, especially when dried, the tube 2.5–3.5 mm long, the lobes 1.5–4.5 mm long, the sinuses (gaps) rounded between the lobes. Corolla tube (2.2) 4.5–5.5 mm long, the lobes lavender, spreading, (2.5) 3–4 mm long. Stamens well exserted, the anthers conspicuous, the free base of the filaments hairy. Fruits fleshy and edible, orange or red, the seeds many, 1.5–2.2 mm long. Flowering in warmer months except during drought.

Possibly occurring locally in the southern margin of Organ Pipe at Senita Basin, and known from collections nearby in the Río Sonoyta valley in Sonora south of Quitobaquito (Felger 2000). This species has been reported from Organ Pipe by Chiang (1981) and others, but we have not found identifiable specimens and it is otherwise not known to be native in Arizona. In a later publication, Chiang and Landrum (2009) make no mention of this species for Arizona.

Gulf of California region including islands, western Sonora and Sinaloa, and both Baja California states, and southern California. Generally in xeroriparian or alkaline semi-riparian habitats. It might be confused with *L. parishii; L. brevipes* usually has larger flowers, often larger and greener leaves, and stouter twigs and branches, and densely crowded flowers.

Another variety of *L. brevipes* occurs in coastal areas and the Channel Islands of southern California.

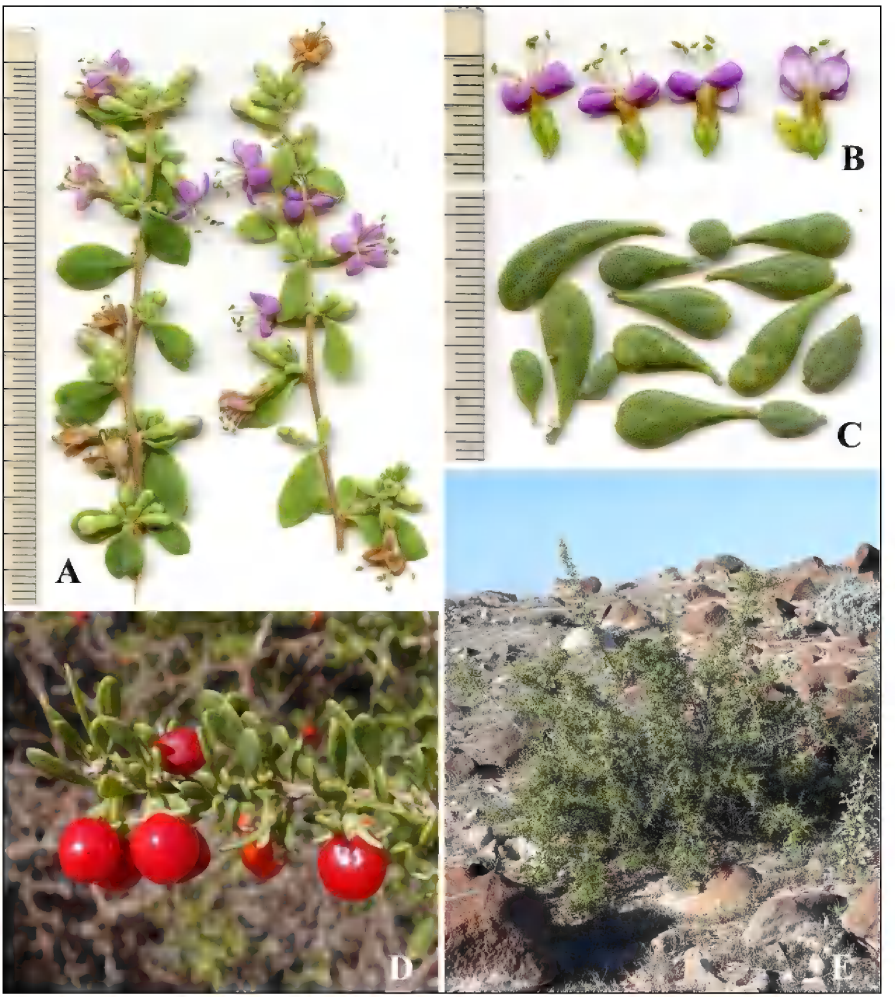

Figure 8. *Lycium brevipes* var. *brevipes*. (A–C & E) Puerto Peñasco, Sonora, 19 Feb 2015. (D) San Carlos, Sonora, 30 Oct 2013, photo by Sue Carnahan.

Lycium californicum Nuttall ex A. Gray var. **californicum**
[*L. californicum* var. *arizonicum* A. Gray. *L. carinatum* S. Watson. *L. californicum* var. *carinatum* (S. Watson) F. Chiang. *L. californicum* subsp. *carinatum* (S. Watson) Felger & C.H. Lowe]
California desert-thorn. Figure 9.

Low, spreading and densely branched shrubs, as wide as or wider than tall, mostly less than 1 (1.3) m tall; mostly branching at right angles, the twigs relatively short, very rigid, stout, and thorn-tipped. Short-shoot (fascicled) leaves mostly 2.5–8 mm long, very succulent, terete, often bead-like and pear-shaped to globose; larger long-shoot leaves often 6.5–21.5 × 1.7–3.5 mm, often linear-terete

to linear-oblong or spatulate or narrowly oblanceolate. Flowers subsessile, 6.5–7 mm long when fresh, including stamens and the short pedicel. Fresh calyces 2.6–4.3 mm long, succulent, the angles of the tube and lobes rounded, often becoming keeled upon drying; calyx lobes 4, or occasionally 2, opposite lobes reduced. Corollas white, 4-lobed, 4–5.3 mm wide, the lobes spreading, sometimes with lavender near the throat. (Occasional flowers have a 2- or 3-lobed perianth.) Stamens conspicuously exserted, the filaments white; anthers and stigma yellow-green. Style white, well exserted. Flowering in late winter and early spring. Fruits 3–4 mm long, orange, rounded to oval, the pericarp thin and scarcely fleshy; fruits 2-seeded, the seeds embedded in a bony endocarp; the endocarps 2.5–3.5 mm long, whitish, oblong-obovoid, grooved along the lower ⅔ of their common surface, the outer surfaces convex and smooth.

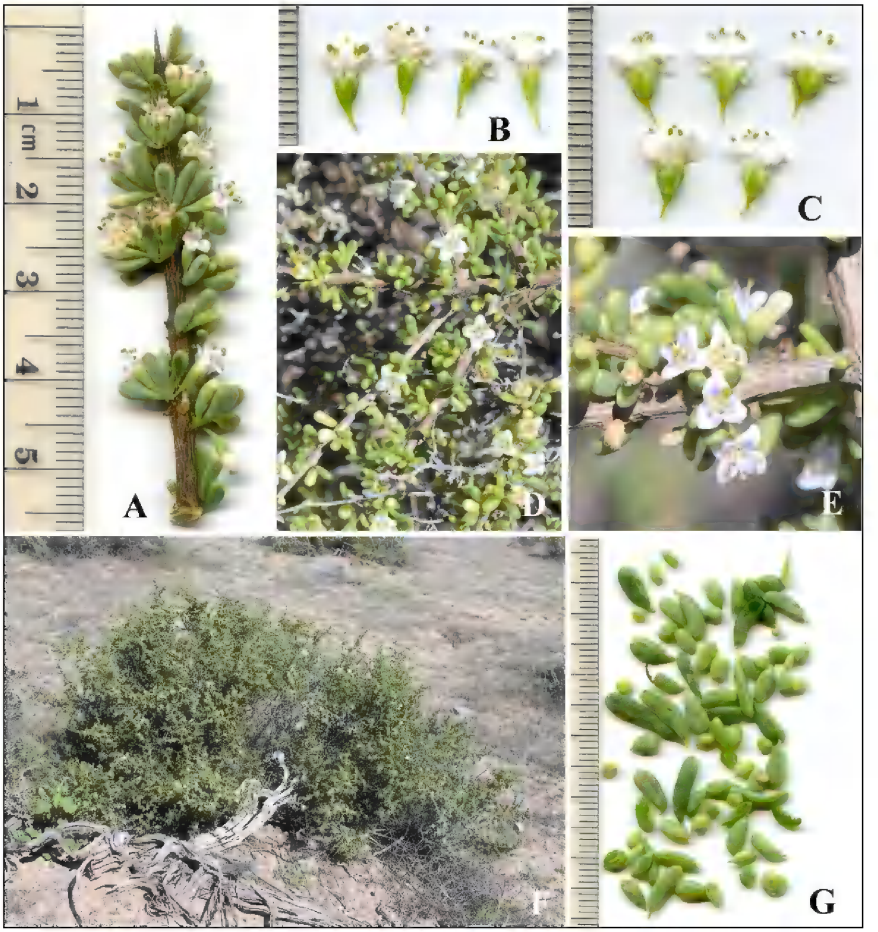

Figure 9. *Lycium californicum* var. *californicum*. La Abra Plain near South Puerto Blanco Drive: (A, B, D–F) 25 Feb 2015; (C) 23 Sep 2014; (G) 15 Mar 2015.

An extensive but geographically isolated population occurs on the La Abra Plain in Organ Pipe and adjacent Sonora near the international border 5–7 km east of Quitobaquito. It is locally common on this sandy desert plain dissected by small washes and low, broad floodplains, where it grows with *Lycium fremontii*, *L. parishii*, and *Atriplex polycarpa*. Another population, apparently much smaller, occurs in Cabeza Prieta west of Tule Tank.

Yeung et al. (2005) indicate that *L. californicum* in the flora area is diploid, and that diploid populations have bisexual flowers. Populations at the periphery of the geographic range of *L. californicum* var. *californicum* tend to be polyploids with male and female flowers on separate plants (Yeung et al. 2005).

Variety *californicum* (including var. *arizonicum* and var. *carinatum*) ranges from central Arizona to coastal Sonora nearly to Sinaloa, and is disjunct in southwestern California and both Baja California states. Variety *interior* F. Chiang is geographically isolated in the southern reaches of the Chihuahuan Desert in northern Mexico.

OP: La Abra Valley near Santa [sic] Domingo (probably in Sonora; there was no border fence or border road at that time), 13 Apr 1941, *McDougall 87*. La Abra Plain, 3.5 mi E of Aguajita Wash on South Puerto Blanco Drive, 24 Oct 1990, *Felger 90-472*.

CP: Wash that crosses Camino del Diablo 1½ mi W of Tule Tank, uncommon, 15 Jan 2005, *Rutman 2005-0115-8*.

Lycium exsertum A. Gray
Arizona desert-thorn; *salicieso*. Figure 10.

Densely-branched shrubs often reaching about 2.5 m tall. Leaves, pedicels, and calyces glandular hairy and viscid. Leaves 1.5–4 cm long, spatulate to obovate. Pedicels 4–12 mm long, flowers usually pendulous. Male and female flowers on separate plants, or some plants with morphologically bisexual flowers. Calyx tube 3.5–4 mm long, the lobes 0.5–2 mm long and unequal; calyx rupturing and spreading as the fruit develops. Corollas, filaments, anthers (before anthesis), and style mostly white, or the corollas tinged with pale violet, the stigma green. Corolla tube 7.5–8.5+ mm long, hairy inside, narrowed below, moderately flared above, the lobes 1.5 mm long and spreading. Stamens exserted on staminate plants; free portion of filaments very densely hairy below. Fruits fleshy, orange, and edible; many-seeded. Flowering at least in February.

Locally common in or near the Ajo Mountains, extending to higher elevation generally above other lyciums, and occasional in the Puerto Blanco Mountains (e.g., Senita Basin).

Much of Arizona except the northeastern of the state, western Sonora, and Baja California Sur.

This species and *L. fremontii* are reliably distinguished only when in flower. *Lycium exsertum* is generally functionally dioecious in a manner similar to *L. fremontii,* to which it is closely related. *L. exsertum* can be distinguished by its usually pendent flowers, shorter pedicels, more campanulate (less tubular) calyx, dirty white and more flaring corollas, long-exserted stamens (on male flowers) and densely hairy filaments. As in *L. fremontii*, the male flowers are larger than the female flower. It is a species with diploid and tetraploid members, with $n = 12$ or 24, whereas *L. fremontii* is polyploid (Chiang-Cabrera 1981; Chiang & Landrum 2009). *Lycium exsertum* is readily distinguished from *L. brevipes* by its often unisexual flowers, longer pedicels, non-keeled calyces, white and more slender and elongated corollas, and non-congested flowers. *Lyicum exsertum* and *L. fremontii* occur side-by-side in Organ Pipe at least in Alamo Canyon near the well, Aguajita Wash near Bonito Well, and Kuakatch Wash along the eastern 1 mile within the Monument.

OP: Along wash at Senita Basin, flowers white, pendulous, 26 Feb 1978, *Bowers 1092* (ORPI). Alamo Canyon, canyon bottom, 2600 ft, 16 Feb 1979, *Bowers 1564.* Arch Canyon, *Wirt 27 Feb 1991.* Kuakatch Wash, 0.5 mi W of E boundary of Organ Pipe, *Rutman 25 Feb 1994* (ORPI).

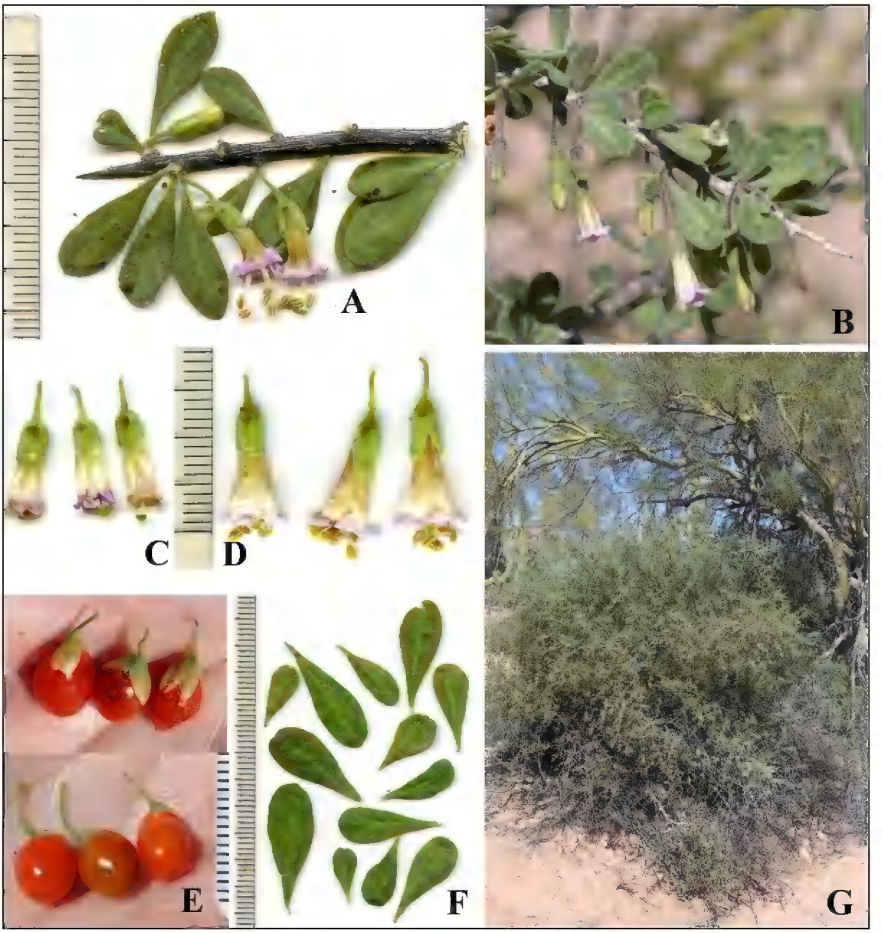

Figure 10. *Lycium exsertum.* Alamo Canyon: (A, C, F) 14 Feb 2015; (E) 4 Apr 2015. (B) Kuakatch Wash near E boundary of ORPI, 13 Mar 2010. (D) Estes Canyon, 25 Feb 2015. A & D, male flowers; C, female flowers.

Lycium fremontii A. Gray var. **fremontii**
Frémont wolfberry, desert goji-berry; salicieso; kuavulĭ. Figure 11.

Densely branched shrubs 1.5–2.5 m tall (to 4 m growing up under mesquite trees along washes such as south of Aguajita Spring), the twigs mostly thorn-tipped. The younger leaves, especially petioles, and leaves among inflorescences, as well as inflorescences and calyces have a mixture of short gland-tipped hairs as well as multi-celled non-glandular hairs, which at low

magnification look glandular, but high magnification shows they are not glandular. As these parts mature or age, they tend become glabrate or glabrous, or at least lack glandular hairs. Most leaves 1–5 (6) cm long, spatulate to obovate or elliptic; older leaves often succulent.

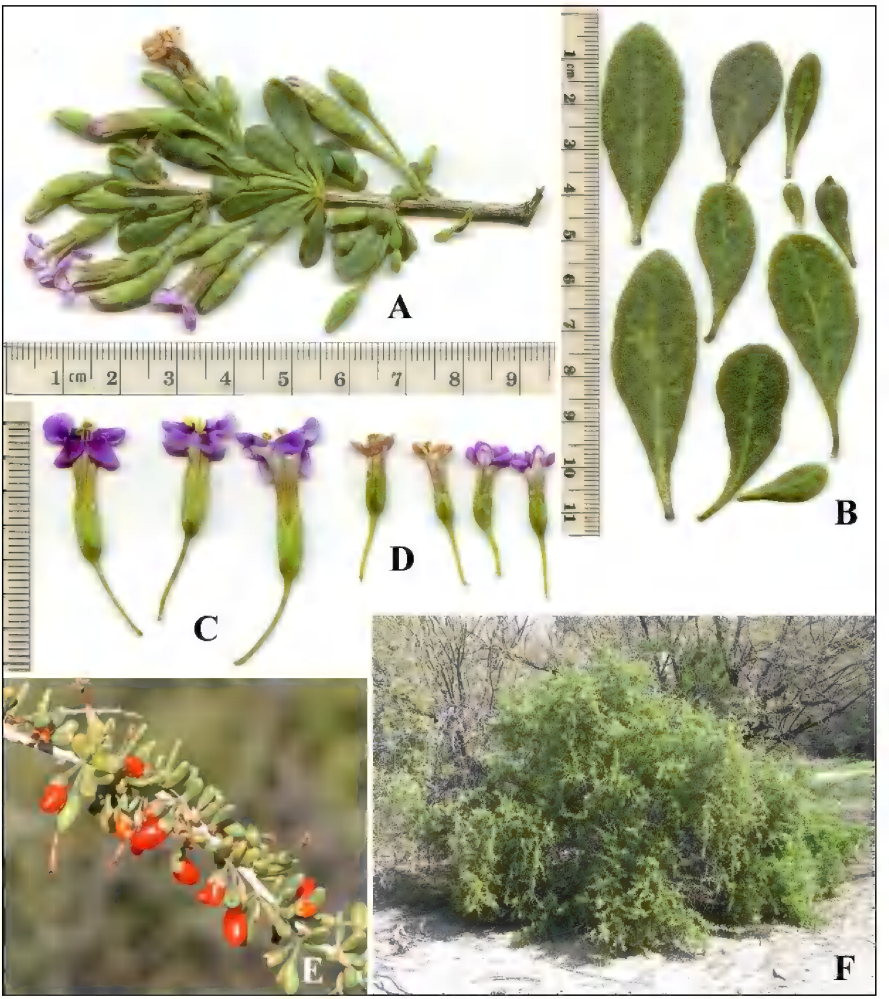

Figure 11. *Lycium fremontii* var. *fremontii.* (A) Plant with male flowers, Alamo Canyon, 14 Feb 2015. (B) Kuakatch Wash near E boundary of ORPI, 11 Mar 2015. Quitobaquito: (C) Male flowers, 25 Feb 2015; (E) 9 Mar 2008; (F) 1 Jun 2010. (D) Female flowers, Rio Sonoyta, 15 miles W of Sonoyta, Sonora, 8 Feb 2015.

Male and female flowers on separate plants. The male flowers are larger, have fertile, exserted stamens and included and reduced sterile styles and stigmas, and do not produce fruit. The female flowers are smaller, have exserted styles and stigmas, included sterile anthers, and produce

fruits. This species also has plants with morphologically bisexual but mostly functionally female flowers (Miller & Venable 2002). Among all flowers: pedicels 6–18 mm long; calyx tube 3.5–7 mm long; corolla tube 4–15 mm long, glabrous inside, the lobes spreading, pale to dark lavender. Stamens (male flowers) with free portion of the filaments glabrous or moderately hairy. Calyx (female flowers) rupturing and spreading as the fruit develops. Fruits orange, juicy, and edible, usually longer than wide, and many-seeded. Seeds 1.7–2.1 mm long, light tan, compressed, the surfaces minutely pitted and tuberculate (closely resembling those of *L. parishii*). Flowering (January) February and March (May), and often also October and November; fruiting about one month after flowering.

Widely scattered and locally common, mostly along washes and low-lying alkaline-soil flats from Organ Pipe to Tinajas Altas.

Arizona except the northern and eastern portions, deserts in southern California, both states of Baja California, and western Sonora. Another variety occurs on the Baja California Peninsula.

This lycium is readily recognized by the glandular hairs on the herbage, pedicels, and calyx, long pedicels, dimorphic as well as bisexual lavender flowers, and relatively large, soft, and fleshy fruits.

The fruits were an important food resource, eaten fresh but especially cooked, and also dried like raisins (Felger & Moser 1985; Felger et al. 1992; Rea 1997). Rea likened the fruits to cranberries. Most people added sugar to cooked lycium fruits. This species produces larger fruits and probably larger yields than most other regional lycium species. The fruits are similar to goji berries, and Richard has advocated developing this lycium as a desert-adapted agronomic crop, giving it the name "desert goji-berry." The Tohono O'odham made hunting bows from the wood (Castetter & Underhill 1935).

OP: Quitobaquito: *Nichol 28 Mar 1939*; 7 Jun 1975, *Chiang 664* (ASU, DES); 10 Mar 2001, *Miller 01-6*. Wash near Dos Lomitas, 28 Jan 1978, *Bowers 1011*. 3.5 mi E of Aguajita Wash on south Puerto Blanco Drive, 24 Oct 1990, *Felger 90-468* (ARIZ, ASU).

CP: Near Cabeza Prieta, 21 Mar 1933, *Shreve* (label damaged, number missing). 7.8 mi on Camino del Diablo W of Pinta Sands, 1 Feb 1992, *Felger 92-42*. Daniels Arroyo, 26 Sep 1992, *Harlan 327*. Heart Tank, 27 Feb 1993, *Felger 93-168*. Tule Well, 27 Feb 1993, *Felger 93-170*.

TA: Below Tinajas Altas, wash, 19 Feb 1979, *McLaughlin 1967*. Coyote Water, 25 Oct 2004, *Felger 04-48*.

Lycium macrodon A. Gray var. **macrodon**
Desert wolfberry; s-cuk kuavulĭ. Figure 12.

Spinescent shrubs 1.2–2.3 m tall, usually with stout rigid branches and twigs, the long-shoot nodes often bearing stout spines. Leaves (especially their bases), pedicels, and calyces minutely and sparsely to relatively densely glandular hairy, or the leaves glabrous or glabrate. (Better-watered plants tend to be glabrous or less pubescent.) Leaves linear-spatulate to obovate or oblong, narrowed to a short petiole or subsessile. Long shoots often with relatively large, glaucous-blue succulent leaves, the larger ones 25–50 × 8–13+ mm; short-shoot leaves mostly smaller, thinner (less succulent), and greener, the larger ones 16–46 × 4–7 mm. Pedicels often 3 mm long. Calyx about ⅔ as long as the corolla tube, the lobes slender and much longer than the tube. Corolla tube 8.5–10.5 mm long, white with green veins in the throat, the lobes white, often with a slight bluish tinge, triangular and reflexed. Stamens and style scarcely or not at all protruding from the corolla; filaments glabrous; stigma green. Fruits (pericarp) hard, 1 cm long when ripe, conspicuously glaucous, constricted (appearing pinched off) below the middle, notched at the tip, with 2 chambers (locules),

the upper part of each locule producing 1 or 2 seeds enclosed in an endocarp; lower part of fruit producing ovules but these aborting. Endocarps often 5.5–6 mm long, bony and sculptured, not grooved and not flattened, the seeds often 3.5–4 mm long, flattened, orbicular to oblong. Flowering mostly February and March, the fruits ripening early April to early May. The green and white flowers and the hard, green fruits are unique among the regional lyciums.

Washes, sand flats, and alluvial flats, often locally common in widely scattered sites across Organ Pipe and Cabeza Prieta, and at Tinajas Altas where it was also present at least 8200 years ago.

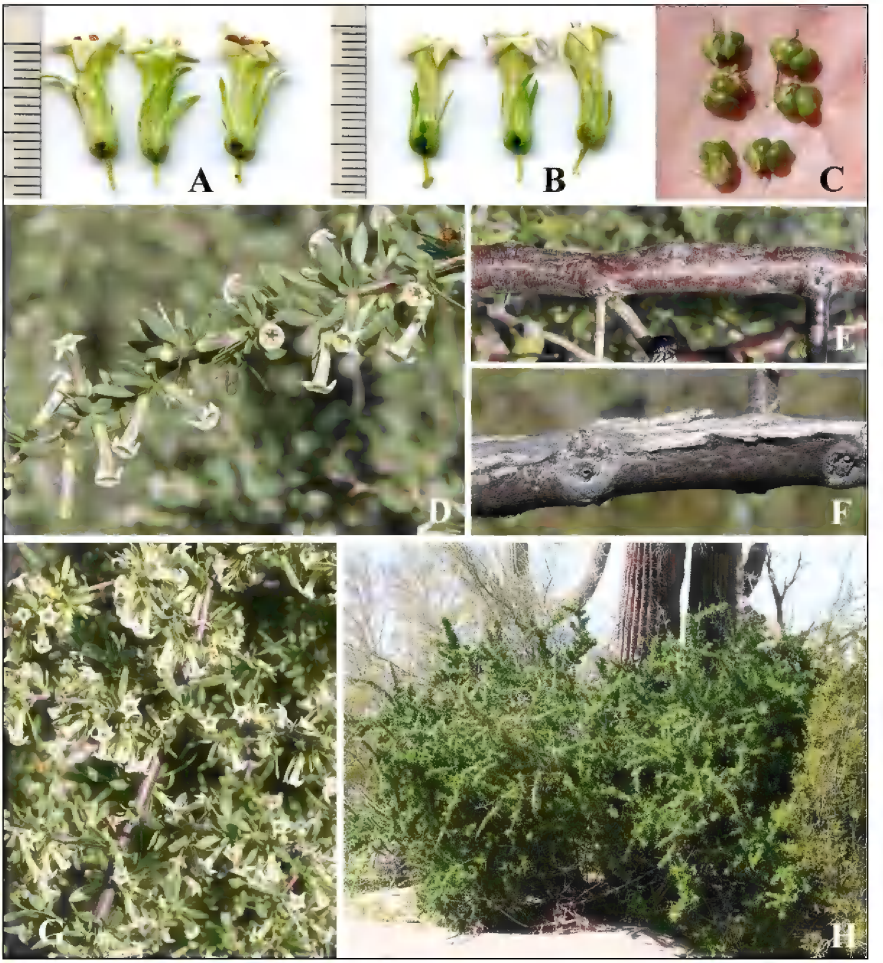

Figure 12. *Lycium macrodon* var. *macrodon*. (A) Ajo, 8 Mar 2015. (B) Hwy 8, 35 km S of Sonoyta, Sonora, 9 Mar 2015. (C) Unripe fruits, Hwy 86, mile 95, 16 Apr 2015. (D) Sierra Los Tanques, Sonora, 17 Feb 2008. (E) Crater Range, Maricopa Co., 7 Jan 2014. (F) Quitobaquito, 20 Mar 2005. (G) Ajo, 27 May 2015. (H) Kuakatch Wash near Hwy 85, 13 Mar 2010.

Variety *macrodon* in southwestern and central Arizona and northwestern Sonora. Another variety in central to southwestern Sonora.

OP: Quitobaquito: 28 Jan 1894, *Mearns 2740* (CAS); 6 Apr 1988, *Felger 88-311.* Bates Well, 23 Apr 1942, *Cooper 574.* Puerto Blanco loop, 1.3 mi S of junction with Bates Well Road, 7 Jun 1975, *Chiang 663* (ASU). Armenta Ranch, *Wirt 25 Mar 1990* (ORPI). Kuakatch wash near E boundary, 9 Feb 2001, *Rutman*, observation.

CP: Monreal Well, *Simmons 20 Oct 1962* (CAB). Papago Well, 10 Apr 1978, *Lehto 22453.* Pinta Sands, 1 Feb 1992, *Felger*, observation. Road to Lower Well, 25 Feb 1993, *Felger 93-68.* Heart Tank, 27 Feb 1993, *Felger 93-168.* Chinamans Flat, 15 Mar 1993, *Harlan 376.*

TA: Tinajas Altas: 29 Mar 1930, *Harrison 6571; Van Devender 25 Mar 1980.* Coyote Water, 25 Oct 2004, *Felger*, observation. †Butler Mts, twigs, leaves, seeds, 8160 ybp.

Lycium parishii A. Gray var. **parishii**
Parish wolfberry; *salicieso.* Figure 13.

Shrubs often 1.2–2 m tall, the twigs often thorn-tipped. Herbage, pedicels, and sepals conspicuously glandular pubescent. Older twigs and stems often light grayish and striate (occasionally dark colored), and relatively slender. Leaves ovate to obovate or spatulate, narrowly to broadly so, 3–18 mm long; foliage often grayish green. Pedicels 2–5 mm long. Calyx tube 1.5–3.5 mm long; lobes mostly more than ⅔ to nearly twice as long the tube, blunt-tipped, usually (1) 1.8–6.5 mm long; calyx sinuses mostly acute in flower, obtuse in fruit. Corollas lavender, sometimes becoming white with age; corolla tube 4.5–8.5 mm long, the lobes 1.3–3.5 mm long and lavender. Stamens exserted and readily visible due to spreading of corolla lobes, the free portion of filaments glabrate or sparsely hairy near base. Fruits 5–9 mm long, globose-ovoid, fleshy, orange, and many-seeded. Seeds 1.7–2.2 × 1.3–2 mm, pale tan, compressed, variable in shape, somewhat D-shaped, the surfaces minutely tuberculate (closely resembling those of *L. fremontii*). Flowering after rains, especially February and March, sometimes also August–November; fruiting about one month after flowering.

Widespread and very common across the flora area; washes, flats, canyons, and rocky slopes.

Southwestern and south-central Arizona, inland southern California, Baja California, and northwestern Sonora. Another variety occurs in northeastern Mexico.

Readily recognized by the pale-colored stems, pale gray-green foliage, and pale lavender flowers with highly variable calyx lobes often much longer than the calyx tube.

OP: Growler Valley, 30 Mar 1933, *Shreve 6208.* Canyon Diablo, 21 Mar 1935, *Kearney 10828.* Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939.* Organ Pipe headquarters area, 10 Apr 1941, *McDougall 74.* Dripping Springs, 15 Apr 1952, *Parker 7913.* Arch Canyon, 28 Mar 1965, *Niles 540.* Darby Well Road, at Bates Well, 7 Jun 1975, *Chiang 661* (ASU). Quitobaquito, 10 Nov 1987, *Felger 87-292.*

CP: Papago Well, 23 Nov 1934, *Goodding 210.* O'Neil Hills, *Darrow 14 Apr 1941.* 2.4 mi W of the eastern boundary of Cabeza Prieta on the Bates Well–Papago Well Rd, San Cristobal Wash, 16 Apr 1976, *Engard 875* (ASU, annotated 1989 by Fernando Chiang, $n = 12$; DES). Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-662.* Road to Lower Well, 25 Feb 1993, *Felger 93-69.* **TA**: Tinajas Altas, near bottom tank, 19 Feb 1979, *Bowers 1584.* Tinajas Altas, *Van Devender 9 Mar 1980.* Coyote Water, abundant, 25 Oct 2004, *Felger 04-49.*

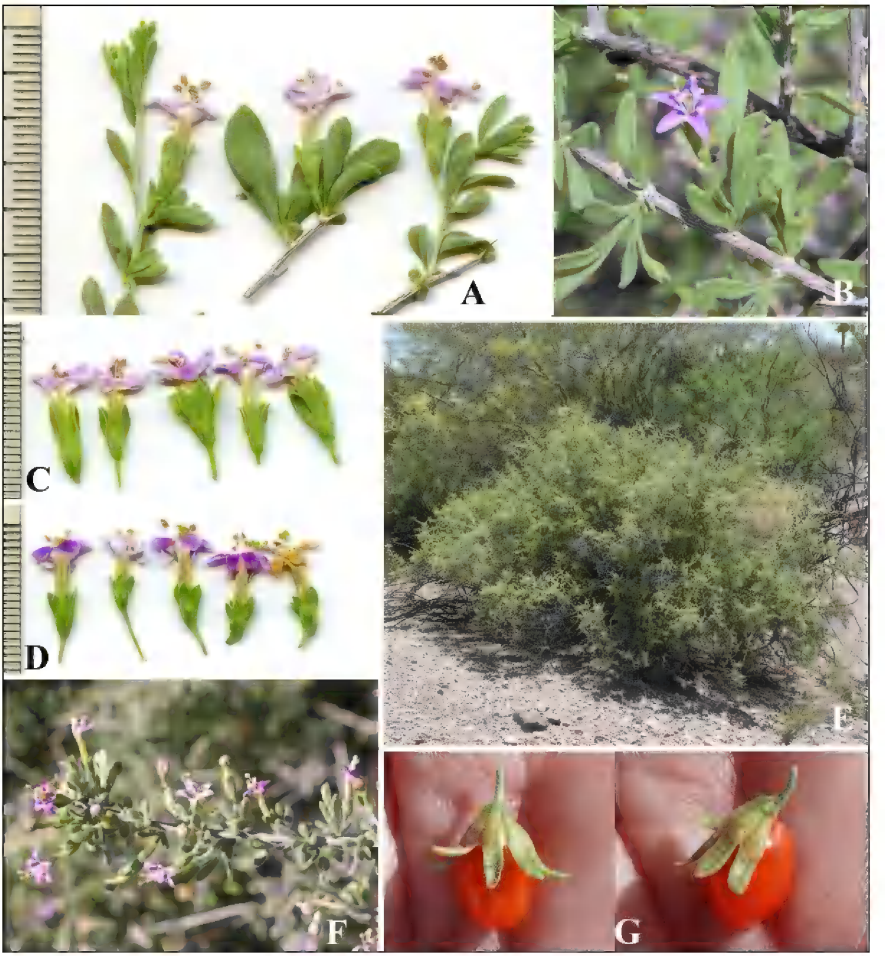

Figure 13. *Lycium parishii* var. *parishii*. (A, D) Ajo Scenic Loop, 31 Jul 2014. Bates Well Road, N of Bates Mts: (B) 24 Feb 2008; (C) 4 Aug 2014; (E) 7 May 2006. (F) Kuakatch Wash near Hwy 85, 13 Mar 2010. (G) Bluebird Mine, 9 Mar 2014.

†**Lycium** sp./spp.

These fossil samples may represent more than one species but demonstrate that members of this genus have been in the Ajo Mountains since at least the middle Wisconsin times.

OP: †Alamo Canyon, twigs, leaves, seeds, 1150 to 32,000 ybp (3 samples). Montezuma's Head, seeds, 17,830 ybp. Puerto Blanco Mts, on ridge, seeds, 7580 to 10,540 ybp (3 samples).

TA: †Tinajas Altas, seeds, 4010 to 10,950 ybp (4 samples).

Nicotiana – Tobacco

Annuals or perennial herbs, rarely shrubs. Leaves mostly entire, usually viscid pubescent, rarely glabrous. Flowers often opening and fragrant at night. Calyx 5-lobed, persistent. Corollas 5-lobed, with a well-developed tube. Fruit a capsule; seeds minute and numerous. Mostly in the Americas, tropical and warm temperate; 60 species. Includes commercial tobacco, *N. tabacum*, and ornamental garden annuals.

Traditional Native American tobacco included *N. rustica* and *N. tabacum*. Smoking was largely ceremonial, often restricted to use by shamans (Castetter & Bell 1951; Rea 1997). "The Cahuillas' use of both wild and cultivated tobacco, however, extended to men and women, especially older people, who smoked it almost daily when the plant was available. Tobacco was considered a relaxing euphoriant as well as a medicinal and ritualistic plant" (Bean & Saubel 1971: 93). Tobacco was smoked in cane pipes (see *Phragmites*) or less often in clay pipes in historic times (Castetter & Bell 1951). Alarcón in 1540 and Hardy in 1826 found tobacco used at the Colorado delta, but it is not possible to know if this was wild or cultivated (Felger 2007; Flint & Flint 2005; Hardy 1829). Childs (1954: 29) wrote that the Hia-Ced O'odham "smoked it from time immemorial. That is why they killed so many immigrants coming and going to California in 1848 and 1849—they wanted to get what tobacco they carried along with them." These events occurred before Tom Childs was born, and perhaps the reasons for these attacks were more complex (Felger 2007).

1. Glabrous shrubs; corollas yellow..... **Nicotiana glauca**
1. Glandular-pubescent annual or perennial herbs; corollas white or cream-white.

2. Spring ephemerals; leaves sessile to short-petioled, the stem leaves not clasping; flowers pure white, nocturnal..... **Nicotiana clevelandii**
2. Perennials, sometimes flowering in the first season; leaves all sessile, the stem leaves clasping (the leaf base wraps around the stem); flowers cream-white, diurnal..... **Nicotiana obtusifolia**

Nicotiana clevelandii A. Gray

Desert tobacco; *tabaquillo del coyote*; ban vivga. Figure 14.

Winter-spring ephemerals, 10–75 cm tall, mostly with a single main axis, or the more robust plants often with several axes. Stems and leaves viscid (sticky) hairy. Leaves variable, quickly wilting, lanceolate to elliptic or ovate, the larger ones (4) 5–13 cm long, the leaf tip acute to sometimes obtuse. Early leaves in a basal rosette; lower leaves with winged petioles, the stem leaves reduced upward and sessile. Calyx lobes slender, 1 lobe wider than the others and conspicuously longer than the capsule, the other lobes about as long as to shorter than the capsule. Corollas white, 12–20 mm long, nocturnal, closing in the morning depending on temperature. Capsules 5.8–8 mm long.

Often along washes and beneath large shrubs or trees; mostly sandy to gravelly soils of washes, bajadas, and desert plains. Southwestern part of Organ Pipe, lowlands across much of Cabeza Prieta (probably not in the northeastern part), and Tinajas Altas.

Southern Arizona to the Guaymas Region of Sonora, and southern California to Baja California Sur.

The leaves were smoked but considered inferior to cultivated tobacco, as indicated by its "coyote" name (Bean & Saubel 1972; Felger & Moser 1985).

OP: Aguajita, 11 Feb 1978, *Bowers 1044* (ORPI).

CP: Pinta Sands, *Phelps, Dale, & Edwards 11 Jan 1978* (ASU). 5.6 mi E of Tule Well, 9 Mar 1980, *Reichenbacher 478.* Papago Well: 12 Mar 1983, *Daniel 2673* (ASU); 26 Feb 1993, *Felger 93-136.* 7.8 mi on Camino del Diablo W of Pinta Sands, 1 Feb 1992, *Felger 92-44.* Pinta Sands, 11 Apr 1993, *Felger 93-432.*

TA: Tinajas Altas, 26 Mar 1935, *Kearney 10913.* 4 mi E of Tinajas Altas, 16 Apr 1941, *Benson 10810.*

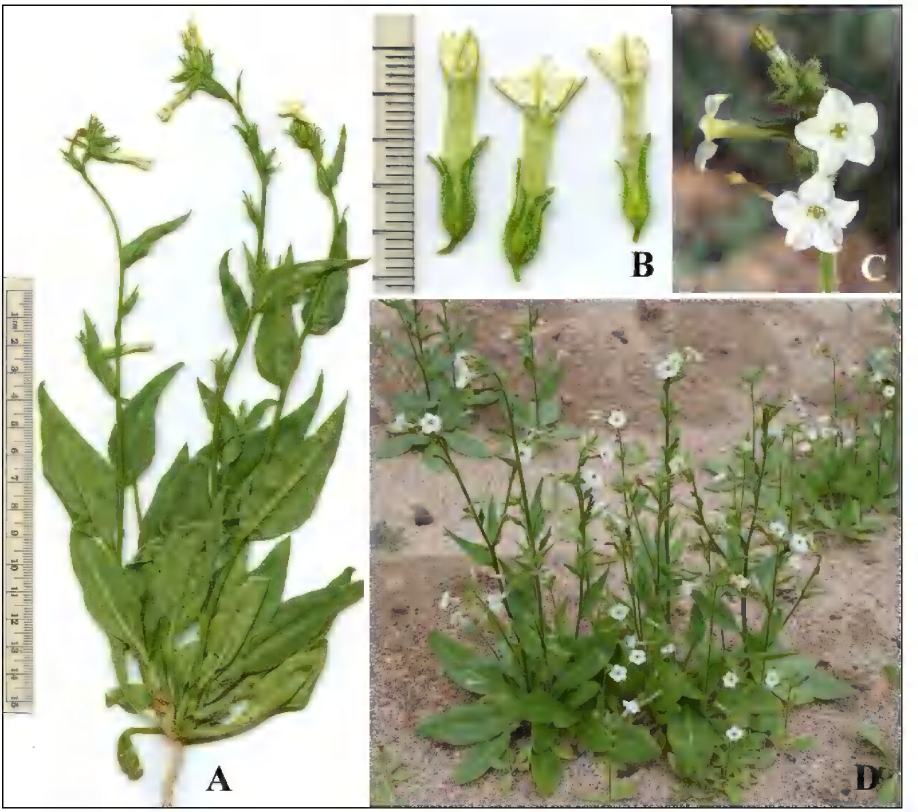

Figure 14. *Nicotiana clevelandii.* (A–C) Dunes near Maya Palace, E of Puerto Peñasco, Sonora, 20 Feb 2015. (D) Puerto Peñasco, Sonora, 19 Feb 2005.

****Nicotiana glauca** Graham var. **glauca**
Tree tobacco; *palo loco, juan loco.* Figure 15.

Open, sparsely branched glabrous and unarmed shrubs 2–3 m tall. Leaves ovate, often 5–20 cm long, glaucous, smooth and somewhat thick. Flowers frequented by hummingbirds, the calyces green, the corollas tubular, yellow, 3–4 cm long.

Urban and agricultural weed in nearby Mexico. One plant was found near the Visitor Center and removed; it has not established in Organ Pipe.

Native to northwestern Argentina and southern Bolivia, now adventive in warm regions of the world. Another variety occurs in South America.

OP: Hwy 85, near Visitor Center, one plant, growing from seed brought with straw mulch for highway construction area revegetation, *Rutman 5 Sep 2005*, observation.

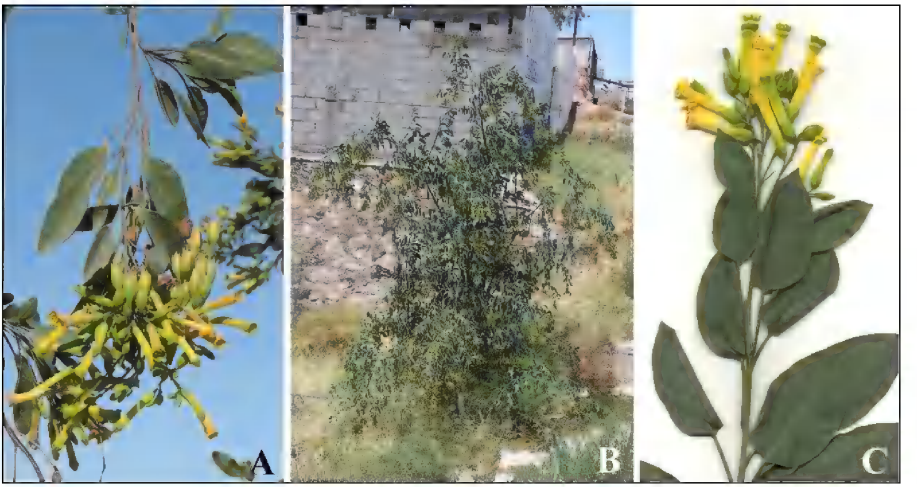

Figure 15. *Nicotiana glauca* var. *glauca*. (A) Puerto Peñasco, Sonora, Feb 2007. (B) Sonoyta, Sonora, 18 May 2015. (C) Ajo, 1 Apr 2013.

Nicotiana obtusifolia M. Martens & Galeotti
[*N. trigonophylla* Dunal. *N. palmeri* A. Gray]
Coyote tobacco, desert tobacco; *tabaco de coyote*; ha-vivga. Figure 16.

Herbaceous perennials, sometimes flowering in the first season, often 0.8–1 m tall. Herbage sticky, glandular-pubescent. Leaves sessile, mostly 6–12.5 cm long, the lower stem leaves oblanceolate with winged petioles and the bases clasping (wrapping around the stem), the upper leaves reduced, sessile and mostly not clasping. Flowers diurnal, open all day. Calyx and its lobes as long as to much longer than the capsules. Corollas 15–22 mm long, cream-white. Capsules 5.8–8 mm long. Growing and reproductive almost any time of year depending on soil moisture, the plants dying back severely during drought. Apparently germinating during the winter-spring season.

Widespread across the flora area; washes, bajadas, canyons, and rocky slopes, often on mountains to their summits. It has been in Organ Pipe for more than 14,000 years.

California deserts to Nevada and Texas, and southward to Nayarit.

The leaves were smoked as tobacco (Felger et al. 1992). "They used to smoke it. I remember my grandmother, she smoked the desert tobacco. Just anybody can smoke the tobacco" (Betty Melvin in Zepeda 1985: 55). The leaves were smoked by people across the Sonoran Desert, although it was universally considered inferior to cultivated tobacco, as indicated by its "coyote" name (Bean & Saubel 1972; Castetter & Bell 1951; Castetter & Underhill 1935; Felger & Moser 1985; Betty Melvin in Zepeda 1985:55; Rea 1997).

OP: Quitobaquito: 30 Jan 1894, *Mearns 2744* (CAS); 10 Nov 1987, *Felger 87-293.* Alamo Canyon, 18 Apr 1942, *Cooper 571.* 2 mi SE of Walls Well, 30 Aug 1945, *Gould 3220.* Dripping Springs, 16 Apr 1952, *Parker 7967.* Arch Canyon, 28 Mar 1965, *Lockwood 152.* Puerto Blanco Drive, 2.5 mi W of AZ Hwy 85, 6 Nov 1977, *Bowers 958.* †Puerto Blanco Mts, capsules, seeds, 9860 & 14,120 ybp.

CP: Heart Tank (Simmons 1966). Salazaria Wash, 11 Apr 1992, *Harlan 202.* Antelope Tank, Cabeza Prieta Tanks, Tuseral Tank, 13–15 Jun 1992, *Felger* (observations). Childs Mt, 18 Aug 1992, *Felger* (observation). Cabeza Prieta Peak, 2550 ft, N facing side of summit, 24 Mar 1995, *Yeatts 3651* (CAB). 0.5 mi S of Sunday Pass, *Cain 15 Nov 2003.*

TA: Base of Tinajas Altas, 28 Mar 1930, *Harrison 6568.*

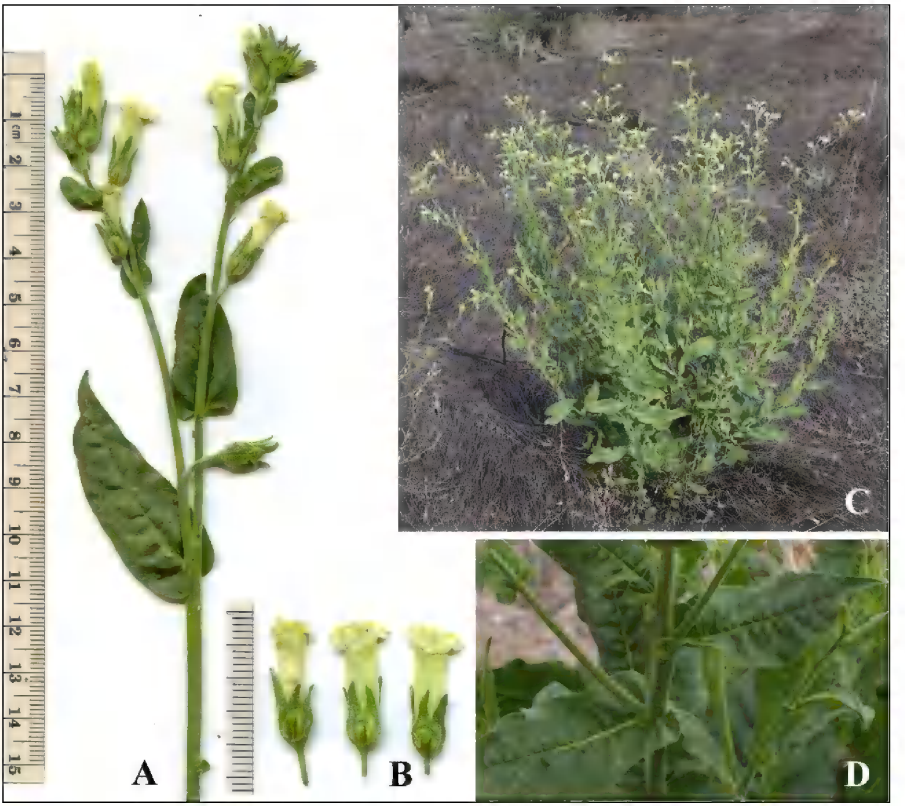

Figure 16. *Nicotiana obtusifolia.* (A & B) Sandy wash crossing at Hwy 85 mile 58.3, near N boundary of Organ Pipe, 25 Feb 2015. (C) Valley E of Childs Mountain, 12 May 2015. (D) Ten Mile Wash at Hwy 85, 8 Mar 2008.

Physalis – Ground cherry, husk tomato; *tomatillo*

Annual or perennial herbs. Leaves petioled. Flowers mostly solitary in leaf axils, pendent, and pedicelled. Calyx conspicuously 10-veined, enlarging and growing over the fruit to form a bladder-like structure like a miniature paper lantern. Those in the flora area: Corollas rotate, often yellowish or white, usually dark-spotted and hairy toward the center. Anthers yellow or bluish to purplish, opening by longitudinal slits. Fruit a globose, many-seeded berry.

Fruits of the wild species in the region are edible fresh and resemble the domesticated tomatillo (*P. philadelphica* Lamarck) in taste but are much smaller. Worldwide; 85 species.

1. Annuals, usually with a single main axis, the plants generally taller than wide; leaves thin, 5–18 cm long; corollas white with a yellow center; anthers bluish..... **Physalis acutifolia**
1. Perennials and sometimes flowering in the first season; plants often as wide as or wider than tall; leaves often slightly thickened, 1.5–10 cm long; corollas and anthers dull yellow.
..... **Physalis crassifolia**

***Physalis acutifolia** (Miers) Sandwith
[*P. wrightii* A. Gray]
Sharp-leaf ground cherry. Figure 17.

Warm-weather annuals, often 25–60+ cm tall, with a well-developed main axis. Younger herbage, flowering calyces, and fruiting calyx bases with short thick white hairs, the younger plants sometimes with elongated simple hairs near the base of the stem, the plants otherwise glabrous or glabrate. Leaves relatively thin, lanceolate, coarsely and often deeply toothed, the larger ones often 5–18 cm long (including petioles). Pedicels slender and elongate, the fruiting pedicels 2–5 cm long. Corollas 10–15 mm wide, white with a yellow center. Anthers blue-gray, the pollen yellow.

Figure 17. *Physalis acutifolia*. (A) W of Tejano Spring, Salero Ranch, 8 mi ESE of Tubac, Santa Cruz Co., photo by Sue Carnahan. (B) Verde Valley near Cottonwood, Yavapai Co., 3 Sep 2012, photo by Max Licher.

Agricultural weed in the Sonoyta region in Sonora and sometimes spreading into the southeastern margin of Organ Pipe where it is probably not well established. It is probably not native to the flora area, although it is native in the Southwest. Gila River Pima children ate the fruits fresh (Rea 1997).

Southeastern California, Arizona, Texas, Chihuahua, Sonora, and Sinaloa; weedy over most of its range.

Physalis acutifolia may be synonymous with *P. lanceifolia* Nees (*P. angulata* var. *lanceifolia* (Nees) Waterfall) of southwestern United States and Mexico.

OP: Dos Lomitas, *Warren 17 Nov 1979.*
CP: Reported from the E edge of Las Playas (Simmons 1966), no specimen located; it occurs in nearby northwestern Sonora (Felger 2000).

Physalis crassifolia Bentham
[*P. versicolor* Rydberg. *P. crassifolia* var. *versicolor* (Rydberg) Waterfall]
Desert ground-cherry; *tomatillo del desierto.* Figure 18.

Perennial herbs often slightly woody at the base and sometimes flowering in the first season. Plants drought deciduous, the stems dying back severely in drought. Stems slender, spreading, and much-branched. Leaves highly variable, 1.5–9 cm long (including petioles), the petioles from half as long as to mostly longer than the blades. Corollas and anthers dull yellow, the corollas 15–22 mm wide. Fruiting calyx (2) 2.5–3.5 cm long. Fruits edible, resembling the domesticated tomatillo (*P. philadelphica*) but much smaller and the flavor inferior. Flowering and fruiting response non-seasonal.

Figure 18. *Physalis crassifolia.* (A) Sierra del Águila near Mex Hwy 2, Sonora, 17 Mar 2015. (B) Sierra Pinacate, near Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 3 Mar 2009. Alamo Canyon: (C) 12 Jan 2014; (D) 17 Oct 2013; (E) 1 Feb 2014.

Widespread across the flora area, mostly on rocky slopes, but also in arroyos or larger washes; probably in all mountains in the flora area.

Arizona, southeastern California, southern Nevada, southern Utah, both states of Baja California, Chihuahua, Sinaloa, and Sonora.

OP: Walls Well, *Nichol 28 Apr 1939.* Alamo Canyon, 7 Oct 1951, *Parker 7731.* Estes Canyon, *Hesselberg 16 Oct 1966.* Cherioni Wash, *Warren 10 Oct 1983.* Bull Pasture, *Wirt 13 Aug 1990.*
CP: Tule Tank, 26 Mar 1932, *Shreve 5930.* O'Neil Hills, *Darrow 14 Apr 1941.* Agua Dulce Mts, 14 Apr 1941, *Benson 10764.* Cabeza Prieta Mts, *Van Devender 9 Mar 1980.* 2 mi W of Little Tule Well, 18 Aug 1992, *Felger 92-653.*
TA: Tinajas Altas, 1 Dec 1938, *Goodding 4902.*

†Physalis sp./spp.

These specimens show that *Physalis* has been a widespread member of the local flora for more than 37,000 years. The seeds are diagnostic only to genus.

OP: †Alamo Canyon, seeds, 1150 to 32,000 ybp (7 samples). Montezuma's Head, seeds, 20,490 & 21,840 ybp. Puerto Blanco Mts, 980 to 10,540 ybp (18 samples; *P. crassifolia* occurs at this site).
TA: †Butler Mts, seeds, 740 to 11,250 ybp (5 samples). Tinajas Altas, seeds, 1230 to > 37,000 ybp (20 samples).

Quincula

This genus has a single species.

Quincula lobata (Torrey) Rafinesque
[*Physalis lobata* Torrey]
Chinese lantern. Figure 19.

Low perennial herbs from a deep, thick root; growth apparently non-seasonal. Stems herbaceous, rather weak, often 18–26 cm long, spreading to decumbent. Herbage granular scurfy with rounded white hairs or trichomes, especially dense on young herbage, pedicels, and calyces. Leaves relatively thick and sometimes semi-succulent, commonly ovate to spatulate, 4–10 cm long, the margins undulate or shallowly to deeply lobed or parted, the petioles prominent and winged. Corollas lavender, 2–3 cm wide, the center with a star-shaped pad of white hairs. Filaments lavender, the anthers yellow. Style pale white, the stigma capitate, yellow. Fruiting calyx 2 cm long. Flowering spring and summer-fall.

Locally common in silty-clay soils of playas and charcos, and sometimes in large washes and on sand flats.

Northern Mexico and Arizona, California, Colorado, Kansas, Nevada, Oklahoma, New Mexico, and Texas.

OP: Dripping Springs, 20 Mar 1941, *McDougall 5.* Near Cherioni Well, 9 Apr 1941, *McDougall 62.* Wash near old ranch by Kuakatch Wash, 31 Mar 1978, *Bowers 1161* (ORPI).
CP: Las Playas, 31 Jan 1992, *Felger 92-14.* San Cristobal Wash, 14 Sep 1992, *Felger 92-685.* Jose Juan Tank, 26 Feb 1993, *Felger 93-101.*

Figure 19. *Quincula lobata.* (A) S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 18 Feb 2015. Pinacate Junction, Sonora: (B & C) 5 Mar 2014; (D) 17 Mar 2014.

Solanum – Nightshade

Annual or perennial herbs and shrubs (elsewhere also vines and small trees), spiny or unarmed, with simple or stellate hairs, or glabrate. Leaves alternate (sometimes sub-opposite), simple (those in the flora area), and petioled. Flowers often showy, the calyx usually 5-lobed, the corollas 5-lobed, rotate, and radial. Filaments short; anthers longer than filaments, connivent (close together but not united) in a cone around the style, each anther cell opening by a terminal pore (part of the buzz-pollination syndrome), or sometimes opening by longitudinal slits. (Other buzz-pollinated genera in the flora include *Senna* in Fabaceae, and *Krameria* in Krameriaceae.) Fruit a rounded berry. Seeds many. The combination of anthers opening by terminal pores and fleshy fruits sets *Solanum* apart from all other plants in the flora area.

Worldwide, especially in tropical America; 1500 species. This large genus includes many economic plants including potato, tomato, eggplant, and a wide range of garden plants.

1. Shrubs, usually spiny; herbage with stellate hairs; corollas lavender, 3–6 cm wide; fruits 2 cm wide, green-mottled..... **Solanum hindsianum**
1. Herbaceous annuals/ephemerals or perennials, without spines; sparsely to densely hairy, the hairs simple or with some branched hairs but not stellate; corollas white or purple, 0.5–2.5 cm wide; fruits to 1 cm wide.

2. Corollas dark lavender or purple, 1.5–2.5 cm wide; fruits green, 1 cm in diameter. ..... **Solanum umbelliferum**
2. Corollas white and sometimes tinged with lavender, 0.5–2 cm wide; fruits blackish or purplish when ripe, 5–9 mm wide.

3. Flowers about 0.5 (1) cm wide, often tinged with lavender; anthers less than 2 mm long; styles up to 0.5 mm longer than the anthers..... **Solanum americanum**
3. Flowers about (0.7) 1–2 cm wide, white; anthers (2.5) 3–4+ mm long; styles 2–2.5 mm longer than the anthers..... **Solanum nigrescens**

***Solanum americanum** Miller
[*S. nodiflorum* Jacquin]
Black nightshade; *chichiquelite*; cuvi vupui. Figure 20.

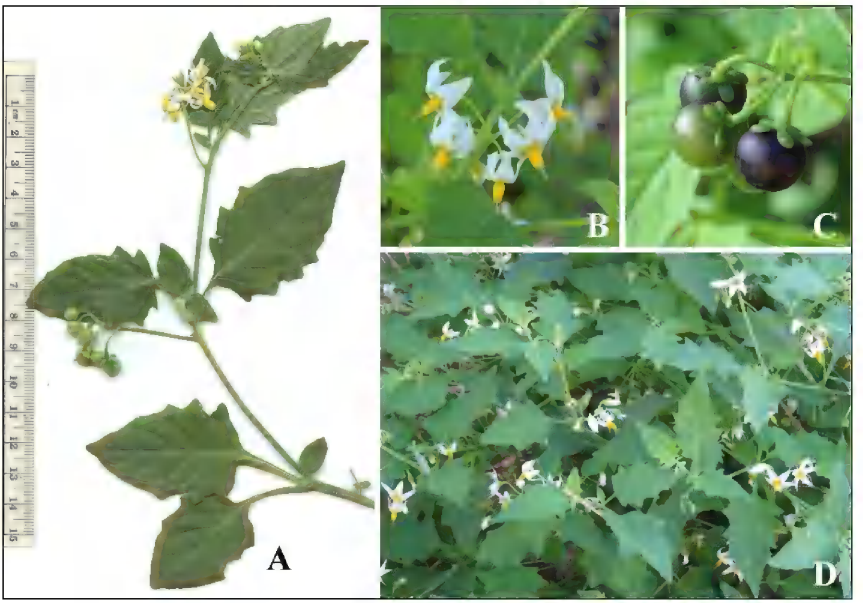

Figure 20. *Solanum americanum.* Alamo Canyon above the well: (A) 3 Sep 2014; (B & C) 9 Sep 2014; (D) 15 Sep 2015.

Annuals or sometimes short-lived herbaceous perennials, relatively open and sparsely branched, often 50–80 cm tall; unarmed. Herbage, especially new growth, inflorescences, outer calyces, and portion of corollas exposed in bud with sparse to moderately dense, short, white, unbranched hairs; older herbage and especially the larger leaves becoming glabrate. Leaves often 5–

20 cm long, the blades variable, mostly ovate, green and thin, the margins usually irregularly blunt-toothed, the petioles prominent. Inflorescences of short umbellate clusters. Corollas white, 5 (10) mm wide, star-shaped with the lobes longer than the short tube. Anthers pale yellow, 1.2–1.3 mm long before dehiscence, 1.5–1.6 mm after dehiscence; style longer than the anthers. Fruiting calyx covering ⅓ or less of the fruit. Berries globose, 5–8 mm wide, dark purplish or blackish.

Growing and flowering with warm weather, frost sensitive and dormant during cooler weather. Aguajita Spring and Quitobaquito in moist, often shaded places. Also an urban and agricultural weed in the nearby Sonoyta region and widely cultivated or protected in Sonoran dooryard gardens.

Nearly worldwide, probably native to South America.

It has been extensively used in Arizona and Sonora as *quelites* (greens) and the small fruits, blackish when ripe, are eaten fresh or cooked (Felger 2007; Hodgson 2001). Gila River Pimas used the ripe fruits as a purple dye (Rea 1997). The plants can be toxic (Kingsbury 1964), although cooking the leaves and shoots can remove the toxin, and upon ripening the toxicity of the berries is greatly reduced (Edmonds & Chweya 1997). Proper identification of the black nightshades is important to avoid poisoning by the more toxic, closely related ones (Kingsbury 1964).

OP: Quitobaquito: In moist soil, 13 Jun 1978, *Bowers 1329*; 28 Apr 1990, *Felger 90-73*. Aguajita, *Warren 10 Nov 1983*.

†**Solanum hindsianum** Bentham
Hind's nightshade, Baja nightshade; *tomatillo espinoso*. Figure 21.

Sparsely branched shrubs to 2.5 m tall; densely stellate pubescent. At least some stems, petioles, leaf midribs, and calyces bear straight, relatively slender prickles to stout "spines." Leaves mostly 3–13 cm long, mostly lanceolate to ovate or oblong, thinner and larger during periods of high soil moisture and warm weather; margins entire or nearly so, or with irregular shallow teeth or lobes. Flowers showy, the corollas 3–6 cm wide, and lavender (plants with white corollas are rare in nearby Sonora); anthers 7–10.5 mm long, bright yellow or yellow-orange; stigma green; flowers largest during times of warm weather and high soil moisture. Fruits round, 2 cm wide, mottled dark and light green. Seeds flat, smooth, and gray. Flowering at various seasons depending on soil moisture and temperature.

Sandy alluvial soil to shallow soils over bedrock in the Puerto Blanco Mountains and at Senita Basin, which are the only known occurrences of this species in the United States. Discovered in Organ Pipe in 1986. It is widespread and common in nearby Sonora.

Endemic to the Gulf of Californica region: Organ Pipe and southward in western Sonora to the Guaymas Region, most of the Baja California Peninsula, and Gulf islands. The northern limit seems to be determined by freezing weather. Freeze damage is commonplace in the northern populations and plants near Sonoyta are sometimes freeze killed nearly to the ground. The only other spiny *Solanum* in the region is *S. elaeagnifolium* Cavanilles, an herbaceous perennial and common weed in nearby northwestern Sonora.

Seeds of fossil specimens indicate this nightshade was a widespread member of the local flora from 11,000 to 20,500 years ago. Seeds of *S. hindsianum* are similar to those of *S. elaeagnifolium* and the fossils could be either species, although *S. hindsianum* seems a more logical choice. *Solanum elaeagnifolium* is a weedy species in southwestern and midwestern United States and northern Mexico.

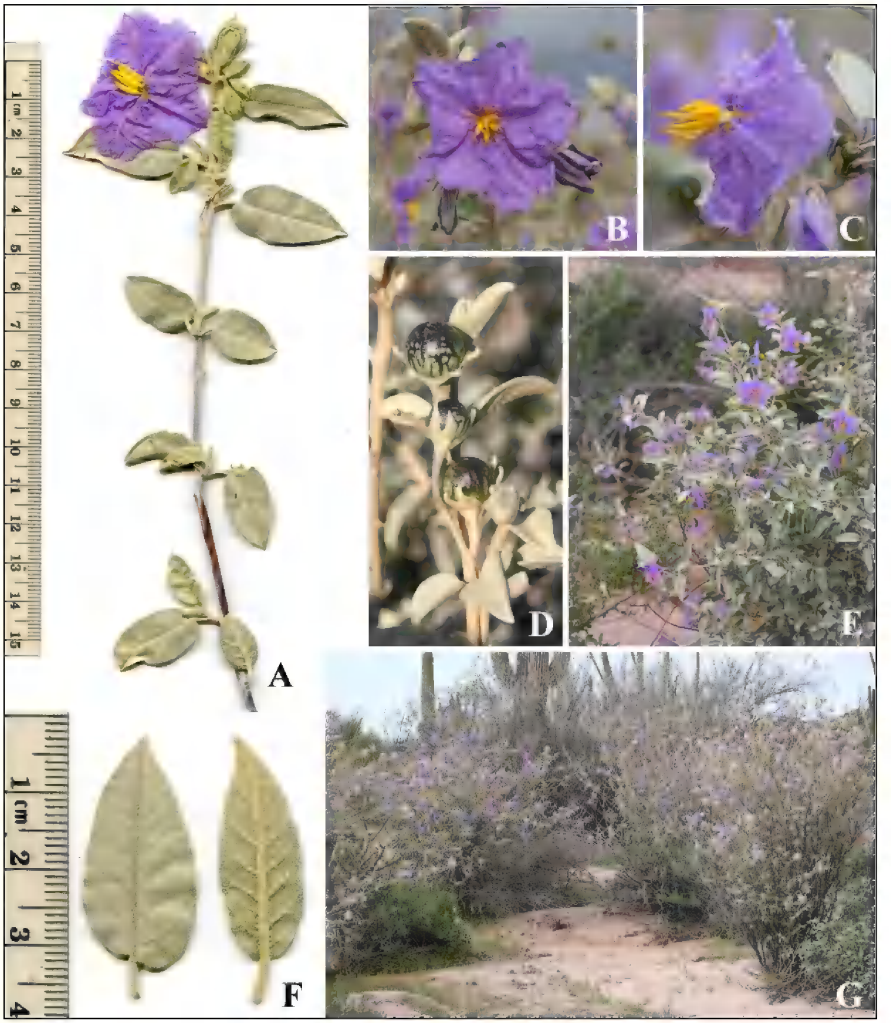

Figure 21. *Solanum hindsianum*. Bajada of Sierra Cubabi, near Mex Hwy 8, Sonora: (A) 12 Sep 2014; (B, C, E, & G) 19 Mar 2010; (D) 18 Jan 2009; (F) 12 Sep 2014.

OP: 1.5 km S of Pinkley Peak, 585 m, *Lechner 28 Jan 1986*. Puerto Blanco Mts, 1 km S of Pinkley Peak, 545 m, shrub to 2 m tall, abundant here, 18 Oct 1987, *Baker 7568* (ASU, ORPI). Puerto Blanco Mts, 1.8 km NW of Red Tank Well, side of wash, about 30 individuals, to 2.5 m tall, 5 Mar 1988, *Baker 7581* (ASU, ORPI). Senita Basin, *Rutman 29 Jan 2002* (ORPI). †Alamo Canyon, seeds, 9570 ybp. Montezuma's Head, seeds, 13,500 & 20,490 ybp.

TA: †Tinajas Altas, seeds, 10,950 ybp.

Solanum nigrescens M. Martens & Galeotti
[*S. douglasii* Dunal]
Douglas nightshade, greenspot nightshade. Figure 22.

Herbaceous to sub-shrubby perennials, also flowering in the first year, usually less than 1 m tall; glabrous or variously pubescent. Leaves alternate or sub-opposite, 2–9 cm long, petioled, the blades ovate to lanceolate-elliptic, margins entire to coarsely toothed. Inflorescences umbel-like racemes. Flowers on pedicels 2–12 mm long. Calyx 1.5–2.5 mm long. Corollas 8–25 mm wide, rotate, white or tinged with purple, sometimes gland-dotted. Styles 3 mm longer than the anthers. Fresh berries blackish, 6–9 mm wide.

Canyons and higher elevations, especially north-facing slopes in the Ajo, Bates, and Diablo mountains.

Generally at elevations above the desert in Arizona. Southern California to Alabama, and Mexico including both Baja California states, and southward to South America.

Differing in part from *S. americanum* by its larger flowers and anthers, and longer styles, indicating an out-crossing rather than selfing mode of reproduction.

OP: Alamo Canyon: *Nichol 4 May 1939*; 17 Dec 1945, *Goodding & Supernaugh 482-45.* Kino Peak, canyons, 18 Mar 1944, *Clark 11416* (ORPI). Canyon Diablo, 15 Apr 1951, *Supernaugh 443.* Arch Canyon, 2 Dec 1990, *Felger 90-506.* Boulder Canyon, *Tewksbury 11 Sep 2004.*

Figure 22. *Solanum nigrescens.* (A) Whiting Ranch Wilderness Park, Orange Co., CA, 19 Jan 2014, photo © by Ron Vanderhoff (http://nathistoc.bio.uci.edu/plants/). (B) Gaviota State Park, Santa Barbara Co., CA, 14 Apr 2003, photo © 2003 by Brent Miller (CalPhotos).

Solanum umbelliferum Eschscholtz
[*S. xanti* A. Gray]
Purple nightshade. Figure 23.

Herbaceous perennials (shrubs and subshrubs elsewhere); with small hairs mostly on stems and leaf veins. Leaves 2–6 cm long, the blades elliptic, ovate or lanceolate, with petioles to 1.5 cm long. Inflorescences of several-flowered umbel-like panicles. Flowers on pedicels 5–15 mm long. Calyx to 7 mm long and wide with lobes shorter than the tube. Corollas dark blue to purple, 1.5–3 cm wide. Anthers longer than the filaments and opening by short slits. Style longer than the stamens. Berries about 1–1.5 cm in diameter, green to yellowish and smooth.

Known in the flora area from a single record.

Western North America from Oregon to Baja California, and eastwards to Nevada and Arizona (Knapp 2013), and undoubtedly also in northern Sonora. Knapp treats *S. xanti* as a synonym of *S. umbelliferum.*

OP: Alamo Canyon, *Tinkham 1 Apr 1942.*

Figure 23. *Solanum umbelliferum.* (A) Quail Springs Ranch, 3 mi SW of Cottonwood, Yavapai Co., 20 Apr 2010, photo by David C. Thornburg (SEINet). (B) Oak Creek Canyon, 16 May 2001, photo by Max Licher (SEINet).

STERCULIACEAE, see MALVACEAE (Felger et al. 2015c, Flora of Southwestern Arizona, part 16).

TALINACEAE – Talinum Family

Three genera; Americas and Africa; 27 species.

Talinum

Herbs and shrubs, often succulent. Africa and Americas; 15 species.

Talinum paniculatum (Jacquin) Gaertner

Pink baby's-breath, jewels of Opar. Figure 24.

Perennial herbs from thick, fleshy, tuberous roots, and also flowering in the first season. Growing during the summer rainy season, dying back to the rootstock when the rains cease, at which time virtually no trace of the plants is evident. Stems and leaves succulent; leaves alternate, falling quickly as the soil dries after the summer rains, the lower leaves (3) 5–15 cm long, elliptic to obovate, the upper stem leaves reduced. Stems 15–60+ cm tall, with terminal inflorescences of open, slender-branched panicles. Flowers on very slender pedicles; open for about three hours in the late afternoon; sepals soon deciduous; petals 3–6 mm long, pink to dark red-purple. Fruits of capsules 3–5 mm wide with many small black seeds 1 mm wide.

Locally abundant on shaded rocky slopes at mid-elevations and especially higher elevations of the Ajo Mountains.

Eastward in southern Arizona to southeastern United States, Baja California Sur, and to South America and West Indies.

OP: Bull Pasture, 3200 ft, *Wirt 8 Aug 1990* (ORPI). Arch Canyon, bedrock/shallow soil NE of the arch, *Rutman 8 Oct 1999* (ORPI). NE-facing slope against wall of bedrock, along the trail below Bull Pasture, *Juniperus coahuilensis, Berberis harrisoniana, Viguiera, Simmondsia chinensis* and many grasses and forbs, 22 Oct 2006, *Rutman 2006-1022-14.*

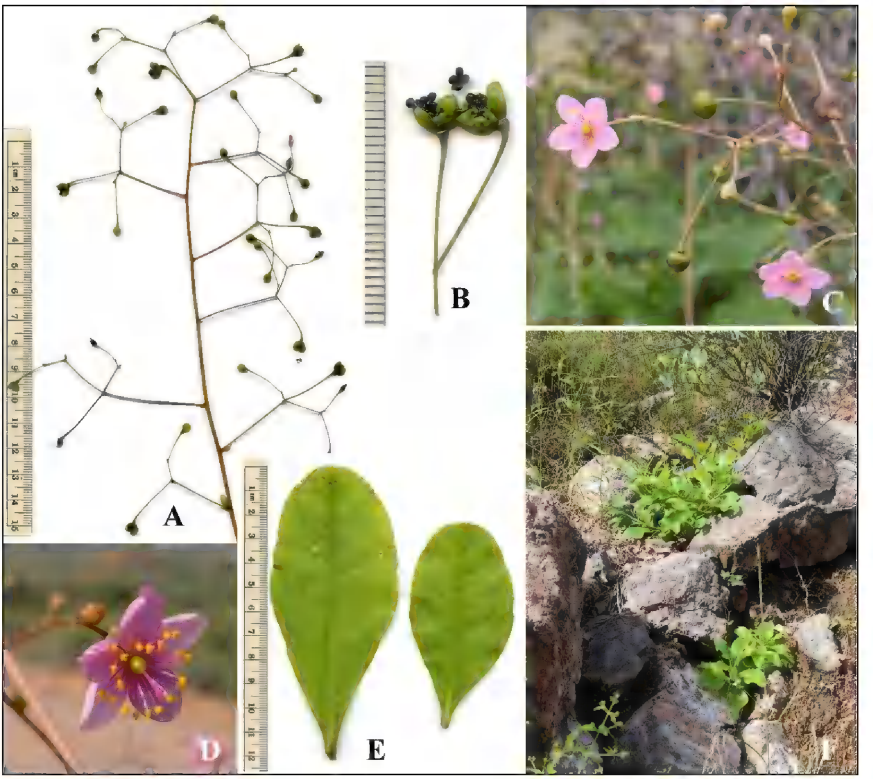

Figure 24. *Talinum paniculatum.* (A, B, E & F) Trail to Bull Pasture, 8 Sep 2014. Salero Ranch, Santa Cruz Co.: (C) 17 Aug 2011; (D) 7 Aug 2013; photos by Sue Carnahan.

TAMARICACEAE – Tamarisk Family

Trees or shrubs. Native to the Old World, mostly xerophytes and halophytes in arid and semi-arid regions; 5 genera, 90 species (Stevens 2012).

Tamarix – Tamarisk

Trees and shrubs. Leaves alternate, scale-like, mostly with salt-excreting glands, clasping or sheathing the stem; without stipules. Flowers in dense racemes or spikes, usually with bracts; flowers small, white or pink, radial, and with a fleshy nectar-producing disk. Fruit a capsule; seeds many, minute, and with a tuft of feathery hairs.

Native to Eurasia and Africa; 55 species.

1. Trees with a massive trunk and limbs, attaining more than 5 m in height; leaves completely encircling the stem, the blades reduced to a cusp less than 0.5 mm long; flowers white, sessile. ..... **Tamarix aphylla**
1. Shrubs, rarely small trees, seldom more than 3–4 m tall; leaves not completely encircling stem, the blade scale-like but evident, 0.7–3 mm long, triangular-ovate; flowers usually pink, sometimes white but becoming pink with age, with pedicels 0.6–0.8 mm long..... **Tamarix chinensis**

****Tamarix aphylla** (Linnaeus) H. Karsten
Athel tree, salt cedar; *pino salado.* Figure 25.

Large trees with a well-developed trunk and thick limbs, and persistent, grayish-green branchlets giving an evergreen aspect. Flowers small and white; flowering in fall.

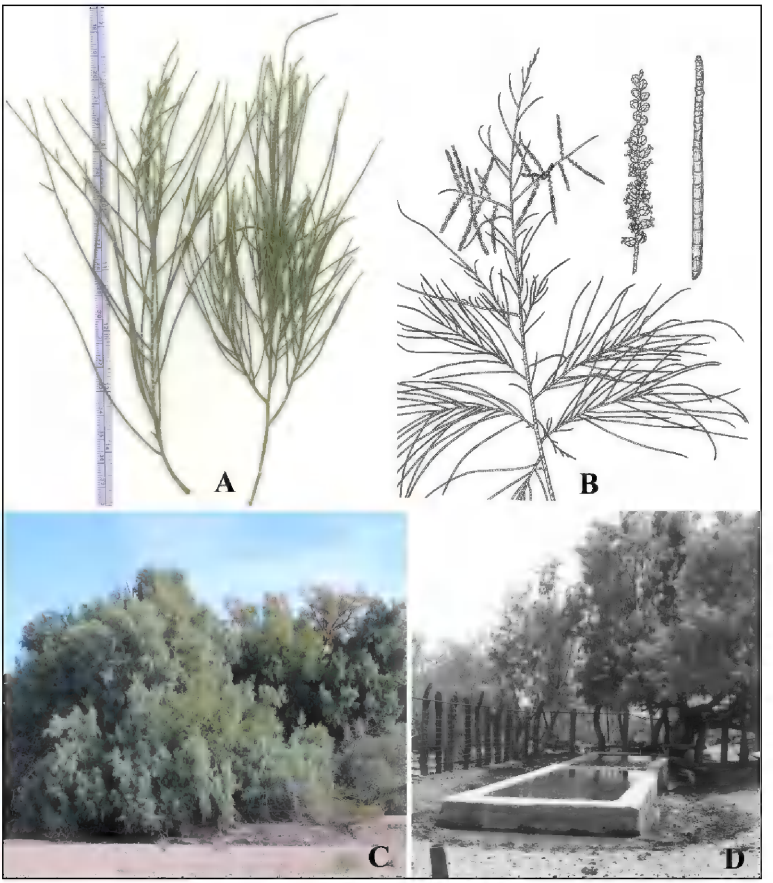

Figure 25. *Tamarix aphylla.* (A & C) El Papalote, Aguajita Wash, Sonora, 6 Feb 2014. (B) By Lucretia Breazeale Hamilton. (D) Pozo Salado, La Abra Plain, Apr 1967, photo by Bill Brown (Organ Pipe Cactus National Monument archives, accession #714).

Formerly planted at ranches and waterholes; once established the trees may survive for decades but are not reproducing in the flora area. As these trees age and become senescent they will be extirpated from the flora area.

Extensively planted in the Sonoran Desert Region; native to North Africa and the Eastern Mediterranean.

OP: Bates Well, one tree next to Henry Gray's house, *Rutman 20 Apr 2001* (ORPI). Observations: Dowling Ranch, one scrawny tree, 11 Nov 1987, *Felger*; Gachado Camp, one tree, 16 Nov 2001, *Rutman*.

CP: Tule Tank (Simmons 1966). Eagle Tank, 31 May 1997, *Bill Broyles* (observation). Tule Well, one tree, 7 m tall, 10 Jan 2002, *Felger 02-15*.

*__Tamarix chinensis__ Loureiro
[Or perhaps hybrids with *T. ramosissima* Ledebour (see Gaskin 2015)]
Salt-cedar, tamarisk; *pino salado*; 'onk 'u'us. Figure 26.

Woody shrubs to about 2.5 m tall. Branchlets (short shoots) or ultimate twigs winter- and tardily drought-deciduous, the internodes shorter than, and obscured by, the overlapping scale leaves. Long shoots perennial. Leaves and young stems with regularly spaced, alkali- or salt-excreting glands (the glands seen with 10× magnification); these glands, glistening gold when fresh and first developing, soon becoming white with the buildup of alkali or salt. Scale leaves of ultimate branchlets (short shoots) 0.7–1.4+ mm long, those of the long shoots mostly 2.3–3 mm long. Flowers 5-merous, the perianth 1.5–2 mm long, pinkish white or pink, the petals longer than the sepals; filaments pink, the anthers white; ovary often dark rose-purple; style yellow or pink, the stigma 3-lobed and white; floral disk glands or nectary maroon, producing glistening nectar droplets; pedicels 0.5–0.8 mm long. Capsules 3.7–4.5 mm long. Seeds 0.5 mm long, yellow-brown. Flowering mostly January–October.

Invasive, weedy, and well established and reproducing on alkaline/saline wet soils at several widely scattered wetland habitats in the flora area, and continuing to appear at new localities. Single plants occasionally are found at dry sites with no indication of supplemental subsurface water, such as near the Mexico border east of Lukeville (e.g., Gachado Line Camp). Park Service personnel have been actively removing tamarisk shrubs. Large populations occur in nearby Sonora, especially along the Río Sonoyta.

Widespread in western North America.

OP: Quitobaquito: 30 Sep 1961, *West 96;* 25 Jul 1978, *Bowers 1391.* Alamo Canyon, *Cole 30 Nov 1988* (ORPI). Gachado Line Camp, dry habitat, one plant, removed, 14 Mar 1995, *Rutman*, observation. South boundary just W of Pozo Salado road, dry habitat, one plant, removed, 14 Mar 1995, *Rutman,* observation. Vicinity of Williams Spring, plants removed, 4 Jan 2002, *Rutman,* observation. Ditch along S boundary road, La Abra Plain near Pozo Salado, dry habitat with no indication of subsurface water, one plant, removed, *Rutman 6 Jan 2002* (ORPI).

CP: Eagle Tank: *Simmons 28 Oct 1962* (CAB); One large shrub in sandy canyon bottom, 13 Jun 1992, *Felger*, observation; No tamarisk seen at Eagle Tank in 2004, Curtis McCasland, pers. comm. to Felger, 2004. Tule Mts, granite bedrock canyon, 6–10 plants less than 2 m tall, all appeared drought-stressed, *Rutman 16 Feb 2002* (CAB).

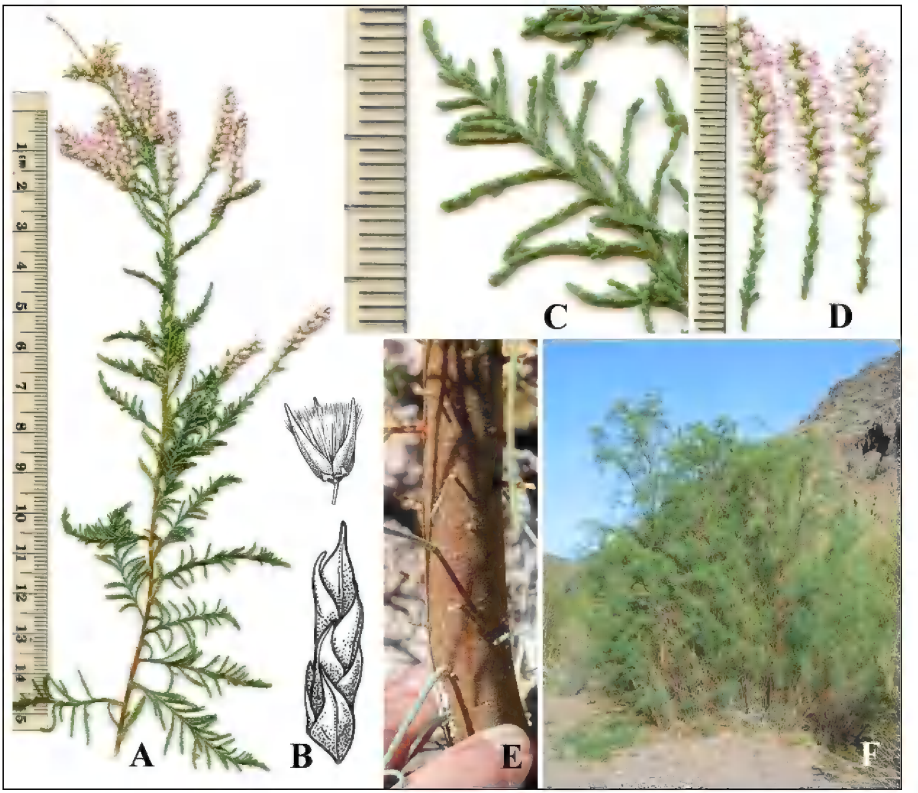

Figure 26. *Tamarix chinensis*. (A, C & D) Ajo Scenic Loop, Little Ajo Mts, 31 Jul 2014. (B) By Lucretia Breazeale Hamilton. (E) Stem of 1-year old plant, Alamo Well, 17 Oct 2013. (F) Gila Box, Greenlee Co., 27 Mar 2004.

URTICACEAE – Nettle Family

Annual to perennial herbs, shrubs, and trees; often with stinging hairs. Stamens spring-loaded, the pollen explosively ejected. Fruits of achenes. Worldwide, mostly tropical and subtropical; 54 genera, 2625 species (Stevens 2012).

1. Delicate annual herbs, without stinging hairs..... **Parietaria**
1. Coarse herbs with stinging hairs..... **Urtica**

Parietaria – Pellitory

Annual or perennial herbs. Worldwide, mostly temperate and subtropical; 20 species.

Parietaria hespera B.D. Hinton var. **hespera**
Desert pellitory. Figure 27.

Delicate winter-spring ephemerals, the root system relatively small. Sparsely to densely hispid, the hairs with enlarged bases. Herbage rapidly wilting when cut. Stems erect to spreading or semi-prostrate, semi-succulent, often 8–60 cm long. Leaves alternate, petioled; leaf blades (5) 8–30 mm long, thin, soft, mostly broadly lanceolate to ovate, and dotted with punctiform cystoliths that appear as minute blisters under magnification; stipules none. Flowers in small axillary clusters, subtended by green bracts (1.4) 2–5 (7) mm long, with bisexual and unisexual flowers in the same cluster. Flowers green, inconspicuous; calyx 4-parted, green to brownish; petals none. Male flowers with 4 stamens, the filaments inflexed in bud, straightening suddenly and elastically to fling the dry, mature pollen from the anthers. Seed-bearing calyces brown, variable in size even on the same stem, 11–26 mm long. Achenes 0.9–1.2 mm long, hard and shiny, ovoid, and enclosed in the persistent calyx.

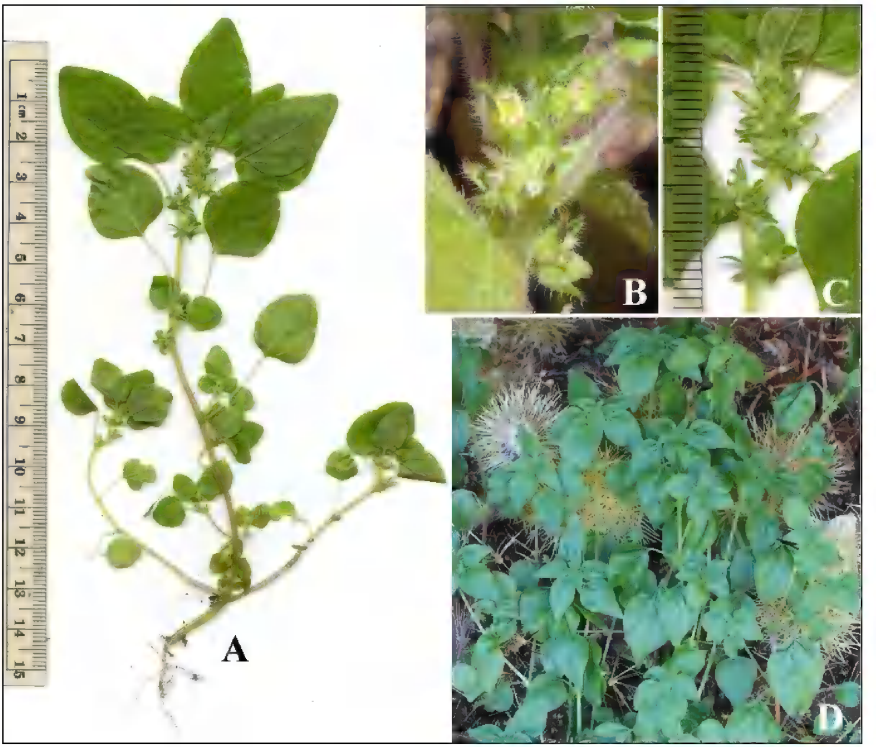

Figure 27. *Parietaria hespera* var. *hespera*. (A & C) Ajo, 6 Mar 2015, C shows female flowers. (B) Male flowers, Alamo Wash, 26 Feb 2014. (D) Bajada E of Charlie Bell Pass, 16 Mar 2015.

Widespread across the flora area at all elevations, except not found on sand flats and dunes. Washes, waterholes, canyons, slopes, and flats, but mostly in protected niches such as among rocks and beneath spiny shrubs and trees. *Parietaria* has been in the Ajo Mountains for at least 32,000 years.

Variety *hespera* in southwestern United States and northwestern Mexico; var. *californica* B.D. Hinton in California and Baja California.

OP: Alamo Canyon, 2 Apr 1944, *Clark 11585* (ORPI). Aguajita Spring, 6 Apr 1988, *Felger 88-298.* Sierra Santa Rosa, 12 Mar 2003, *Felger 03-371.* †Alamo Canyon, fruits, seeds, 1150 to 32,000 ybp (6 samples).

CP: Childs Mt, 25 Feb 1993, *Felger 93-43.* Agua Dulce Spring, 26 Feb 1993, *Felger 93-90.* Jose Juan Tank, 26 Feb 1993, *Felger 93-103* (CAB). Heart Tank, 27 Feb 1993, *Felger 93-151.* Las Playas, clayish soil with mesquite shrubs, 11 Jan 2002, *Felger 02-39.*

TA: Coyote Water, 25 Oct 2004, *Felger 04-55.* Tinajas Altas, 28 Mar 2010, *Felger 10-192* (ARIZ, DES). Canyon ca. 0.1 km below Raven Tank, 29 Mar 2010, *Felger 10-236.*

Urtica – Nettle

Annual or perennial herbs; with stinging hairs, the hairs long, sharp pointed, and with a bulbous or cylindrical base. Temperate regions worldwide; 45 species.

Urtica gracilenta Greene

Mountain nettle. Figure 28.

Herbaceous annuals to 0.5 m tall, growing with warm weather. Leaves opposite; prominently petioled; leaf blades ovate to circular or ovate-lanceolate, about 8–15 cm long, the margins coarsely toothed. Male and female flowers in separate inflorescences, or a few female flowers sometimes at tip of male inflorescences. Flowers green and white, small, and with 4 tepals. Achenes ovoid, 1.5 mm long.

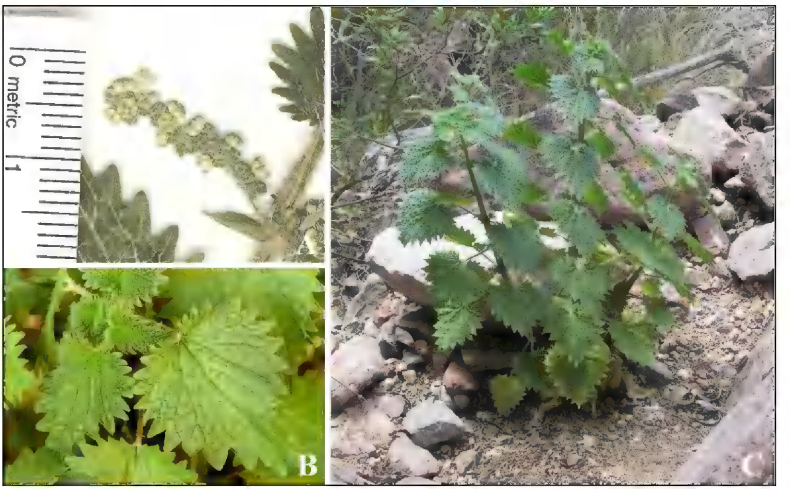

Figure 28. *Urtica gracilenta.* (A) Devil's Chasm, Sierra Ancha Wilderness Area, Gila Co, 6 Aug 1991, *Imdorf 27* (ASU, SEINet). (B) Aguirre Springs, Organ Mts, NM, 22 Apr 2007, photo by Patrick Alexander (SEINet). (C) Arch Canyon, 23 Apr 2015, photo by Peter Holm.

An isolated population discovered by Peter Holm in remote, upper reaches of Arch Canyon. The nearest population is in the Baboquivari Mountains.

Arizona to Texas and northern Mexico.

OP: Arch Canyon, canyon bottom shaded by steep canyon walls and broadleaf trees, main canopy trees are *Sapindus drummondii* and *Quercus turbinella*, understory trees are *Ptelea trifoliata, Frangula betulifolia,* and *Morus microphylla*, shrubs include *Ribes quercetorum* and *Rhus aromatica*, and herbs include *Thalictrum fendleri*, *Phanerophlebia auriculata*, *Urtica gracilenta*, and *Phacelia ramosissima*, *Holm 29 Mar 2015*.

VERBENACEAE – Verbena Family

Annuals, perennial herbs and shrubs (those in the flora area; elsewhere also trees and vines). Stems 4-angled (square in cross-section). Leaves opposite, simple or compound; stipules none. Calyx 4- or 5-lobed or toothed. Corollas 4- or 5-lobed, usually bilateral. Stamens 4. Ovary superior; style 1, the stigma often 2-lobed. Fruits variable, 1- or 2-seeded or separating into four 1-seeded nutlets.

Worldwide, mostly New World, and mostly tropical to warm temperate; 31 genera, 920 species.

1. Shrubs; fruits 1- or 2-seeded.

2. Plants without spines or prickles; flowers white; fruits 1-seeded..... **Aloysia**
2. Stems with scattered prickles; flowers pink (or yellow or red); fruits 2-seeded..... **Lantana**

1. Annual or perennial herbs; fruits of four 1-seeded nutlets.

3. Plants foul-smelling; flowers white or pinkish, in axillary clusters..... **Tetraclea** (formerly in Verbenaceae, now in Lamiaceae, see Felger & Rutman 2015b, Flora of Southwestern Arizona, part 15)
3. Plants not stinky; flowers blue or pink, in terminal spikes, head-like clusters, or racemes.

4. Flowering calyx more than 5 mm long; corollas pinkish, 8–14 mm wide; style more than 5 mm long; nutlets 2.5–3.5 mm long, the ventral surfaces brown or blackish, not white-papillate. ..... **Glandularia**
4. Flowering calyx to 3.5 mm long; corollas pinkish or blue, 2.5–5 mm wide; style 1.5 mm long or less; nutlets 1.7–2.2 mm long, the ventral surfaces white-papillate..... **Verbena**

Aloysia

Shrubs; 35 species in the Americas.

Aloysia wrightii (A. Gray) A. Heller ex Abrams
Oreganillo. Figure 29.

Shrubs often 1–1.5 m tall and about as wide, with 4-angled, very slender, brittle stems with thin bark peeling in long strips. Leaves pleasantly aromatic (like oregano); petioles 1–4 mm long or leaves sessile, the blades often 5–12 mm long, ovate to circular, densely tomentose below, the margins crenate. Inflorescences of slender terminal or lateral spikes mostly 2–6 cm long, densely tomentose, the flowers crowded, and with bractlets shorter than the calyx. Flowers small, bilateral, white, and fragrant. Calyx 4-toothed, 1.5–3 mm long. Corollas 2.5–3.5 mm long, 5-lobed, moderately 2-lipped, white with rounded lobes, the upper 2 larger. Stamens 4. Fruits to 3 mm long with 2 nutlets.

Generally in canyons and especially on rocky, north-facing mountain slopes to upper elevations in Organ Pipe including the Ajo, Growler, Puerto Blanco, and Santa Rosa mountains. Also on Childs Mountain.

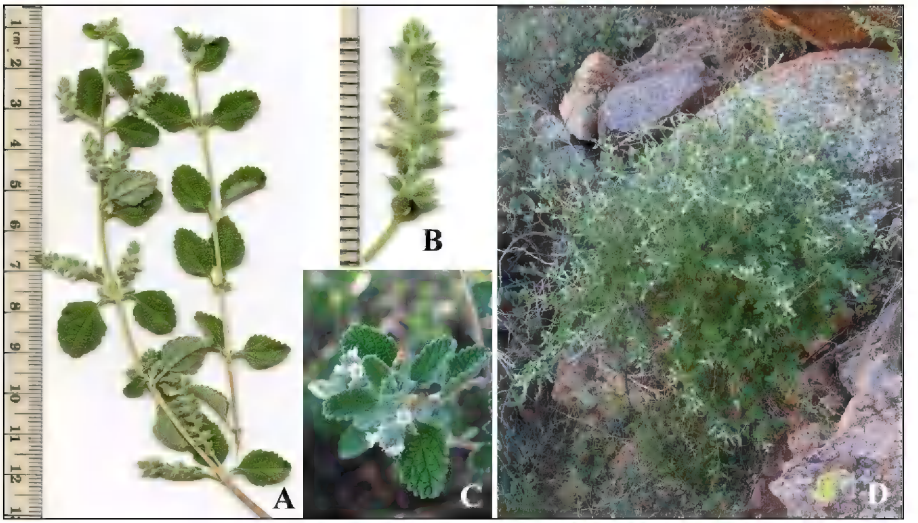

Figure 29. *Aloysia wrightii*. (A & B) Arch Canyon, 26 Aug 2014. (C) Salero Ranch, Santa Cruz Co., 8 Aug 2010, photo by Sue Carnahan. (D) Trail to Mount Ajo, above Bull Pasture, 24 Sep 2006.

Inland southern California to southern Utah, Arizona, New Mexico, Texas, and northern Mexico in Sonora and the Chihuahuan Desert Region.

OP: Sierra de Alamos, *Nichol 16 May 1937*. Puerto Blanco Mts, 22 Oct 1964, *Ranzoni 361* (ORPI). Alamo Canyon, 3 Dec 1977, *Bowers 973*. Gunsight Hills near Kuakatch, *Rutman 22 Mar 1998* (ORPI). E side of Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-296* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger*, observation.

CP: Childs Mt, rocky, N-facing slopes near top, 2240 ft, 25 Feb 1993, *Felger 93-39*.

Glandularia

Ephemerals, annuals or short-lived perennials. Branches and leaves opposite. Leaves simple to bipinnatifid, the leaves or segments usually toothed to cleft, with stiff, simple and sometimes glandular hairs. Inflorescences spicate, not especially slender or elongated in fruit. Each flower subtended by a bract. Calyx tubular, 5-angled, irregularly 5-toothed. Corollas 5-lobed, salverform (the tube abruptly expanded into a flat limb), moderately bilateral and showy. Fruits splitting into four nearly cylindrical 1-seeded nutlets.

Twenty-two species in North America and 50 in South America. A genus segregated from *Verbena*. *Glandularia* originated in South America and can be distinguished from *Verbena* by differences in seed morphology, chromosome number, style length, and reproductive modes.

1. Calyx prominently stipitate (stalked) glandular; nutlets 3.3–3.5 mm long and blackish. ..... **Glandularia gooddingii**
1. Calyx glandular or not, but not stipitate; nutlets 2.5–3 mm long and light to dark brown. ..... **Glandularia latilobata**

Glandularia gooddingii (Briquet) Solbrig
[*Verbena gooddingii* Briquet]
Desert verbena. Figure 30.

Short-lived herbaceous perennials or non-seasonal ephemerals, but generally occurring in spring; pilose with relatively long, spreading, white hairs plus stalked and sessile glands on the herbage and calyces. Leaves petiolate, 2.5–4.5+ cm long, broadly ovate, highly variable, deeply toothed to laciniately parted. Inflorescences reaching 5–8.5 cm long, the flowers fragrant, crowded into 1 to 3 head-like spicate clusters. Floral bracts 5–7.5 mm long. Calyx 5.5–7 mm long. Corollas lavender-pink, the tube longer than the calyx, with hairs inside and outside, the flat limb ("face") 8–14 mm wide, the lobes notched, the throat white and yellow-green, nearly closed by a dense ring of white hairs guarding the entrance; inner surface of corolla tube with downward-pointing white hairs, these dense just below the anthers and along a line extending inward from the sinus between the 2 larger, lower corolla lobes. Style 5.5–7+ mm long. Nutlets 3.3–3.5 mm long, dark brown to nearly black, the dorsal side resembling a miniature ear of corn with an alveolate pattern and smooth ridges.

Figure 30. *Glandularia gooddingii*. (A) Estes Canyon trailhead, 25 Feb 2015. (B) Bull Pasture Trail, 10 Sep 2008. (C) Alamo Canyon, 29 Jan 2014. (D) Arch Canyon, 2 Aug 2013.

Widespread across Organ Pipe and scarce in the eastern part of Cabeza Prieta; washes, canyons, and rocky slopes.

Southeastern California to western Texas and southwestern Utah, Baja California, Baja California Sur, and Sonora (Nesom 2010a).

OP: Diablo Canyon, 21 Mar 1935, *Kearney 10842*. Alamo Canyon, 2400 ft, 3 Dec 1977, *Bowers 971*. Growler Wash, 0.5 mi E of Bates Well, *Rutman 22 Mar 1998* (ORPI). Bull Pasture: *Wirt 5 May 1989* (ORPI); 3215 ft, 9 Apr 2005, *Felger 05-187* (det. G.L. Nesom; Phytoneuron 2010-54).
CP: Basaltic hill, 0.2 km S of Chico Shunie temporal, 25 Feb 1993, *Felger 93-65*.

Glandularia latilobata (L.M. Perry) G.L. Nesom
[*Verbena bipinnatifida* (Nuttall) Nuttall var. *latilobata* L.M. Perry. *Glandularia bipinnatifida* (Nuttall) Nuttall var. *latilobata* (L.M. Perry) B.L. Turner]
Figure 31.

Ephemerals to short-lived perennials, with harsh hairs (hirsute-hispid), stems becoming decumbent. Leaves subsessile or short-petioled, 1–2-pinnatifid, the ultimate divisions narrow (linear); however, leaves of young plants or lower nodes may have broad lobes. Inflorescences 6–20 cm long, compact, with many, crowded, showy flowers; spikes elongating in fruit. Flowers subsessile to short-stalked. Bractlets shorter than the calyx; calyx 7–8 mm long, glandular, with teeth 1–4 mm long. Corollas bright lavender-purple, the tube 10 mm long, the limb 6–8 mm wide. Nutlets 2.5–3 mm long. Flowering in spring and probably also with summer rains.

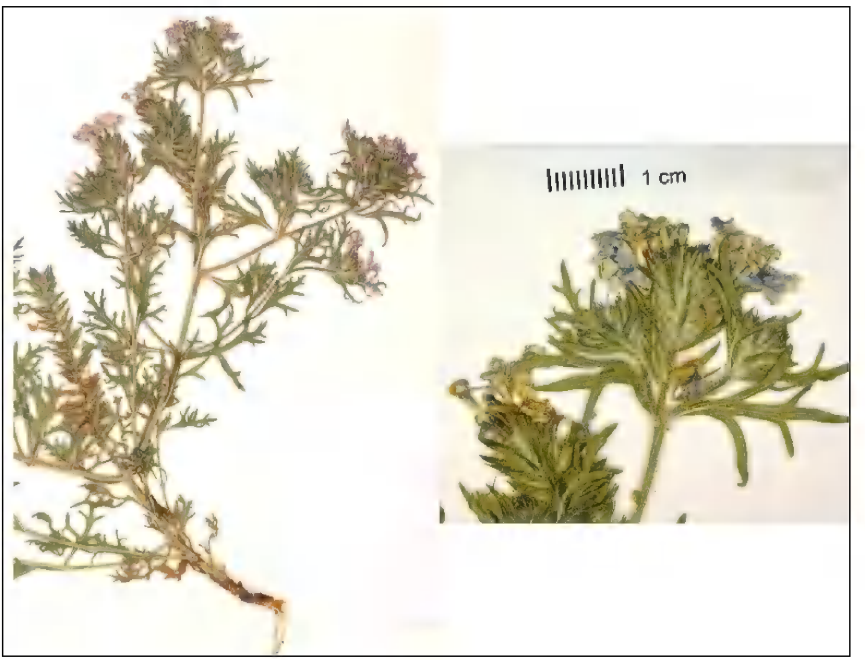

Figure 31. *Glandularia latilobata*. 3.3 km W of Agua Prieta on Mex Hwy 2, Sonora, 24 Apr 2004, *Van Devender 2004-328* (ASU 47736).

Organ Pipe in the Ajo and Bates mountains; washes and canyon bottoms, apparently localized and not common. Also just east of the northeast boundary of Cabeza Prieta.

Widespread in Arizona, mostly above the desert including high-elevation forests, New Mexico, northeastern Sonora to Chihuahua, and Durango (Nesom 2010b).

OP: Alamo Canyon, *Tinkham Apr 1942*. Bates Well, sandy bottoms, 18 Mar 1944, *Clark 11427* (ORPI). Growler Wash, about 0.5 mi E of Bates Well, uncommon, *Rutman 22 Mar 1998* (ORPI).

†**Glandularia** sp./spp.

One or more species of *Glandularia*, probably one or both of the present-day species, have long been in Organ Pipe and Tinajas Altas, as shown by fossil nutlets.

OP: †Alamo Canyon, seeds, 1150 to 32,000 ybp (3 samples). Montezuma's Head, nutlets, 13,500 to 21,840 ybp (3 samples, including: one nutlet 3.0 mm long, brown, 20,490 ybp; one nutlet 2.4 mm long, 21,840 ybp; one nutlet 3.1 mm long, dark brown, 21,840 ybp). Puerto Blanco Mts, nutlets, 9070 & 9720 ybp.

TA: †Tinajas Altas, nutlets, 8660 ybp.

Lantana

Tropical and subtropical regions, worldwide but mostly in the Americas; 150 species.

****Lantana camara** Linnaeus

Lantana; *confiturilla negra*. Figure 32.

Shrubs with brittle, prickly stems and scabrous leaves. Flowers in a head-like globose cluster, the corollas bicolored. The one specimen has pink and yellow corollas. Fruits of small, round, fleshy drupes, black when ripe.

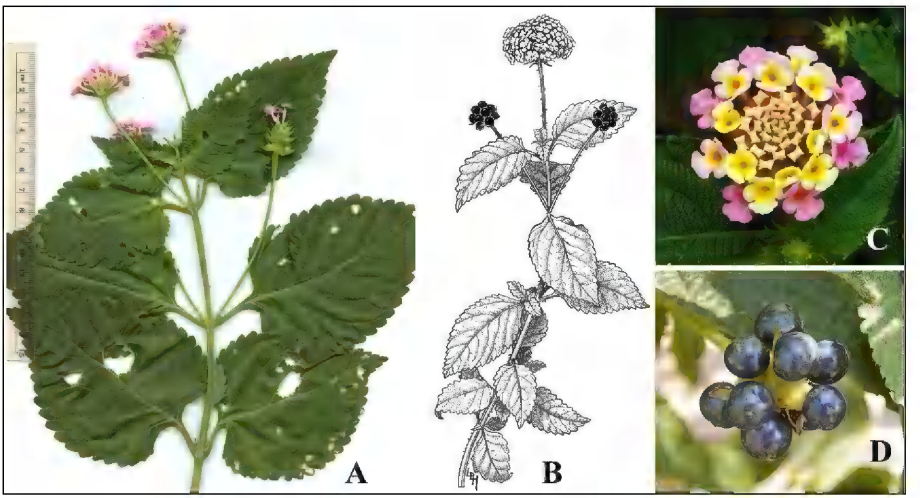

Figure 32. *Lantana camara*. (A) Tucson, 28 Sep 2014. (B) By Lucretia Breazeale Hamilton. (C) Mauritius, October 2006, photo by Joaquim Alves Gaspar (SEINet and Wikipedia). (D) 11 Jan 2008, photo by Frank Vincentz (Wikipedia).

Garden plant in the Organ Pipe residence area; first noticed escaping in 1997, but it has not spread. It is a common landscape plant in southern Arizona and this color form is a horticultural selection. This species is native to Central and South America.

OP: Planted in yards of residence and escaping into the wash interior to the residence loop road, *Rutman 24 Mar 2003.*

Verbena

Herbaceous perennials. Leaves toothed to dissected. Flowers in terminal, usually elongated, densely flowered spikes, each flower subtended by a narrow bract. Corollas usually funnelform, sometimes nearly salverform, with a flat, 5-lobed, weakly bilateral limb. Style 3 mm or less in length. Fruits separating into four 1-seeded nutlets (similar to those of *Glandularia*), the nutlets usually falling as a unit, brown or blackish, small (1–2 mm long), the common faces angled.

Mostly in North and South America with greatest diversity in North America, where it seems to have originated (see *Glandularia*); 70 species.

1. Stems usually sprawling or spreading; floral bracts 3.5–6+ mm long; corollas pink.
..... **Verbena bracteata**
1. Stems erect; floral bracts 1.7–3 mm long; corollas blue.

2. Inflorescences of paniculate (many branched) spikes..... **Verbena menthifolia**
2. Inflorescences of 1 or mostly 3 long spikes..... **Verbena xylopoda**

Verbena bracteata Lagasca & Rodriguez
Bigbract verbena. Figure 33.

Spring ephemerals, low-growing, spreading to prostrate, the stems and inflorescences 25–40 cm long, with coarse spreading white hairs (hirsute or strigose). Leaves, flowers, and fruits crowded. Leaves 2–6 cm, more or less lanceolate, deeply toothed or cleft. Inflorescences of several-branched spikes less than 12 cm long. Bracts 6–10.5 mm long. Calyx 2.6–3 mm long. Corollas 2.5–3 mm wide, pink, inconspicuous and nearly hidden by the bracts. Style 0.6+ mm long. Nutlets brown, 2.1–2.2 mm long, resembling a miniature ear of corn, the ventral side white papillate, the dorsal side striate and alveolate.

Figure 33. *Verbena bracteata.* (A) Bear Canyon Lake, Coconino Co., 11 Jul 2005, photo by Patrick Alexander. (B) Quail Springs, SW of Cottonwood, Yavapai Co., 5 Oct 2013, photo by D.C. Thornburg.

Known in the flora area by a single record from a well-established, localized population.

Southern Arizona mostly in disturbed habitats, and often found at dirt cattle tanks (*represos*). The Sonoran Desert populations are few and often widely separated, and likely result from dissemination by birds visiting waterholes. Southern Canada to northern Mexico.

CP: Jose Juan Represo, 12 Jun 1992, *Felger 92-555.*

Verbena menthifolia Bentham
Mint verbena. Figure 34.

Non-seasonal ephemerals to short-lived perennials; few-branched, slender and erect, often 60–100 cm tall, the leaves, flowers, and fruits rather widely spaced. Leaves with sparse to moderately dense pubescence of appressed, stiff white hairs, the stems glabrate or sparsely hairy. Larger, lower leaves 7–8+ cm long, once- or twice-pinnatifid. Inflorescences of several to many slender, mostly erect spikes often 15–30 cm long; bracts 1.7–2.7 mm long. Calyx 2.4–3.5 mm long, hirsute with short, appressed non-glandular white hairs. Corollas bright blue, 4–5 mm wide. Style 1.1–1.5 mm long. Nutlets 1.7–1.8 mm long, brown, and the common ventral surfaces white papillate. Flowering various seasons including spring and summer.

Localized at charcos, playas, alkaline wet soils including Quitobaquito and Jose Juan Represo, and in the Ajo Mountains at least in Arch Canyon on north-facing slopes at higher elevations.

Figure 34. *Verbena menthifolia.* (A) S edge of Las Playas, 3 Jun 1965, *Lehto L22466* (ASU 74831). (B) Lake Pleasant Regional Park, Maricopa Co., 10 Apr 1978, *Lehto 5126* (ASU 97014).

California to southeastern United States and Mexico southward to Oaxaca and Veracruz, and both states of Baja California. Attributions of *V. halei* to Arizona, New Mexico, and northwestern Mexico are based on misidentifications of *V. menthifolia* (Nesom 2010c).

OP: Beneath mesquite in old fields just below pond at Quitobaquito, 14 Sep 1988, *Felger 88-454.*
CP: Jose Juan Represo: 19 Mar 1987, *Elias 10254*; 12 Jun 1992, *Felger 92-556.* Las Playas, 14 Mar 1993, *Harlan 365.* Redtail Tank, *Cutler 3 Mar 1995* (CAB).

Verbena xylopoda (L.M. Perry) G.L. Nesom
[*V. neomexicana* (A. Gray) Small var. *xylopoda* L.M. Parry]
Arizona vervain. Figure 35.

Perennial herbs often 20–50 cm tall with slender, erect, flowering stems (spikes). Herbage with hispid to hispidulous covering of short, stiffly spreading hairs like a bed of glassy tack points and also short, glandular hairs. Leaves mostly basal and on lower stem areas, often deciduous by flowering time, the blades 2–5 (7) cm long, mostly ovate to subspatulate, obovate, or oblanceolate in outline, pinnatifid to deeply pinnately toothed, the upper stem leaves linear and much smaller. Inflorescences of spikes, solitary or 3 (5); 4–20+ cm long in fruit. Floral bracts 3–4 mm long. Calyces 2.5–3.5 (4) mm long. Corollas blue to violet, the tube 4–5 mm long, limb 4–7 (8) mm wide. Nutlets 1.6–2.2 mm long, the outer surfaces reticulate.

Organ Pipe on rocky slopes and in canyons of the Ajo and Diablo mountains. Generally a plant of upper slopes and one lowland record in a sandy wash north of the park headquarters.

Arizona except the northern part, southwestern corner of New Mexico, eastern Sonora, and western Chihuahua (Nesom 2010d).

Figure 35. *Verbena xylopoda.* Alamo Canyon: (A) 7 Sep 2013; (B) 26 Feb 2014; (C) 15 Sep 2013.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10846.* Alamo Canyon, *Nichol 4 May 1939.* Sandy wash N of headquarters, *Ranzoni 26 Mar 1965* (ORPI). Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 551.* Rocky slopes along Bull Pasture Trail, 3000 ft, 9 May 1979, *Bowers 1704.* Bull Pasture, 2315 ft, rocky, shallow soil, 9 Apr 2005, *Felger 05-177.*

VISCACEAE, see SANTALACEAE (Felger & Rutman 2016, Flora of Southwestern Arizona, part 19).

ZYGOPHYLLACEAE – Caltrop Family

Herbs and shrubs (elsewhere also trees). Those in the flora area: Leaves opposite, with 1–10 leaflet pairs, or leaflets 3, the leaflet margins entire; stipules well developed. Flowers solitary in leaf axils, radial, and 5-merous. Ovary 1, superior; style 1, the stigmas 1 to several. Sepals and petals separate; nectary disk usually well developed. Stamens 10. Fruits of capsules or schizocarps, with 5 carpels (splitting into 5 or 10 mericarps); seeds 1 to several per carpel or mericarp. (See Porter 2016.)

Worldwide, mostly tropical and subtropical, and prominent in semi-arid to desert regions; 27 genera, 250 species. Zygophyll shrubs and trees have very hard wood.

1. Shrubs with hardwood stems, often to 1 m or more tall; leaves with two fused leaflets appearing as one..... **Larrea**
1. Ephemerals or herbaceous or scarcely woody perennials less than 1 m tall; leaves with 3 or more leaflets.

2. Perennials and also flowering in first season; stipules spinescent; leaflets 3 (or fewer when some or all leaflets are shed in drought); flowers pink or purple..... **Fagonia**
2. Summer-fall ephemerals; stipules not spinescent; leaves even-pinnate with 6 or more leaflets; flowers yellow or orange.

3. Fruits knobby but not spiny, separating into 10 segments (rarely fewer), these leaving a persistent axis after falling..... **Kallstroemia**
3. Fruits with sharp spines, separating into 5 tack-shaped mericarps (rarely fewer), these leaving no central axis after falling..... **Tribulus**

Fagonia

Herbaceous perennials and often flowering in the first season. Stems slender, brittle, and striate. Leaves digitately compound with 3 leaflets (those in the flora area) and spinescent stipules; one or more leaflets sometimes drought deciduous. Flowers on prominent pedicels. Petals pink or purple, clawed and often twisted at the claw to stand perpendicular to the flower axis. Fruit a capsule resembling a miniature onion dome, ovoid, moderately inflated, deeply 5-lobed and 5-chambered, the persistent style forming a prominent beak. Seeds 1 per chamber, flat, glistening with a hard, nearly transparent surface, becoming mucilaginous (slimy) when wet and adhering tenaciously when dry. Flowering with warm weather at various seasons except in extreme drought. The three fagonias in the flora area tend to occur in open, xeric sites, often on rocky slopes but also along washes, bajadas, and sometimes on sand flats.

Deserts and semi-arid regions of North and South America, Africa and the Mediterranean region to India and Pakistan; 35 species (Beier 2005; Beier et al. 2004).

1. Leaflet tips not spinose; stipules straight, the longer ones 5–12+ mm long. ..... **Fagonia pachyacantha**
1. Leaflet tips spinose; stipules moderately curved (at least some on each plant), 1.5–6 mm long.

2. Herbage nearly or entirely glabrous; lateral leaflets often narrower than the middle leaflet; fruiting pedicels not more than 7 mm long; capsules not glandular ..... **Fagonia laevis**
2. Herbage obviously glandular pubescent; lateral leaflets about the same width as middle leaflet; fruiting pedicels 8–20 mm long; capsules glandular..... **Fagonia longipes**

Fagonia laevis Standley
[*F. californica* subsp. *laevis* (Standley) Wiggins]
Smooth-stem fagonia. Figure 36.

Plants often reaching 30–50 cm across, much-branched with very slender stems. Plant mostly glabrous or glabrate, except the stems scabrous. Leaflets 1–2.5 mm wide, the middle one usually larger and wider than the lateral leaflets; leaflets spinose-tipped. Stipules mostly 1.5–6 mm long and mostly moderately curved. Flowers about 1 cm wide; petals pink to purple; pedicels up to 7 mm long. Capsules often minutely hairy but not glandular; fruiting pedicels less than 7 mm long. Seeds (2.7) 2.9–3.2 × 1.9–2.3 mm, broadly ovate, pale tan to dark brown with age.

Widespread in the western and drier part of the flora area (Shreve's [1951] Lower Colorado Valley vegetation region of the Sonoran Desert): Cabeza Prieta except the eastern margin and the Tinajas Altas Region. Rocky, arid slopes, canyons, and washes near hills and mountains; not on open desert flats.

Southwestern Arizona, southeastern California, both Baja California states, and western Sonora south to the Sierra Seri.

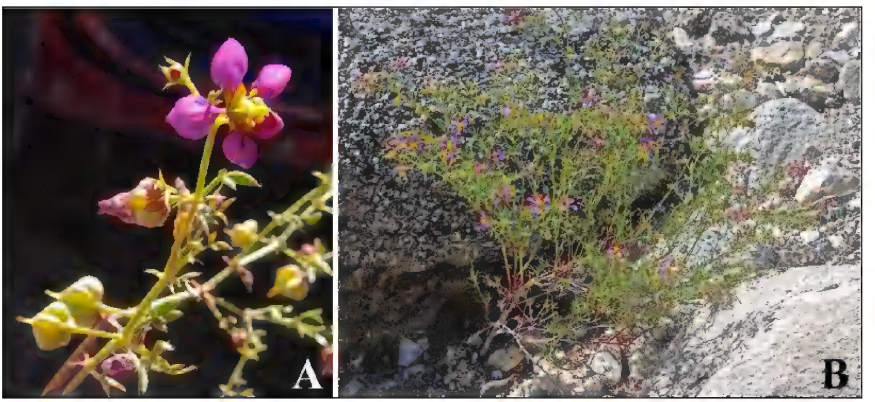

Figure 36. *Fagonia laevis*. (A) Tinaja de los Papagos, Pinacate Biosphere Reserve, Sonora, 24 Feb 2013, photo by Sue Carnahan. (B) Sierra el Águila near Mex Hwy 2 at km 93 west of Sonoyta, Sonora, 17 Mar 2014.

Fagonia laevis and *F. longipes* appear to be closely related, and sometimes have been treated as subspecies of *F. californica*, an apparently related taxon occurring farther south in the Sonoran Desert in Mexico. We follow Porter (1963, 2016) and list *F. laevis* and *F. longipes* as separate species. They do not occur together (sometimes have close but different geographic ranges). In

addition to the key differences, the herbage of *F. laevis* tends to be dark green and that of *F. longipes* grayish green.

CP: Tule Tank, 21 Mar 1933, *Shreve 6229.* Tule Well, 6 March 1940, *Goodding A-9953* (ASU). S end of Cabeza Prieta Mts, 8 mi from Tule Wells, Camino del Diablo, 22 Mar 1979, *Yatskievych 79-253.* Cabeza Prieta Tank, canyon, 6 Apr 1979, *Lehto 23512 (*ASU). W side of Surprise Canyon, 1/4 mi E of Cabeza Prieta Pass, Cabeza Prieta Mts, 10 Mar 1984, *Hodgson 2737* (DES). N side of Tule Mts, 2 Feb 1992, *Felger 92-53.* Salazaria Wash, 12 Apr 1992, *Harlan 208.*

TA: Tinajas Altas Mts, 5 Dec 1935, *Goodding 1741* (ARIZ 103622 & 103624). Borrego Canyon, 27 Feb 1993, *Felger 93-195.* Surveyors Canyon, 29 Mar 2010, *Felger 10-202.* Canyon below Raven Butte Tank, 29 Mar 2010, *Felger 10-230* (ARIZ, DES).

Fagonia longipes Standley
[*F. californica* subsp. *longipes* (Standley) Felger & C.H. Lowe]
Thin-stem fagonia. Figure 37.

Plants generally resembling *F. laevis,* differing in part as follows: Herbage, especially the stems, and capsules obviously glandular pubescent with minute stalked glands, but sometimes becoming glabrate with age. Plants light green to grayish green. Middle and lateral leaflets about the same width. Pedicels variable in length, but mostly 8 or more mm long (drought stressed plants may have some shorter pedicels) and elongating in fruit.

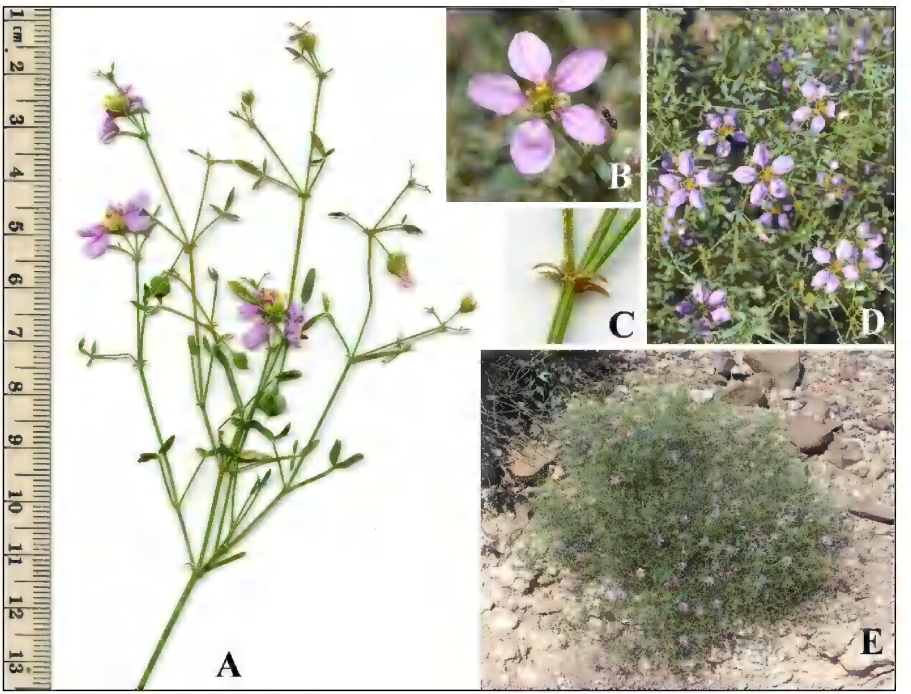

Figure 37. *Fagonia longipes.* (A & C) Ajo Scenic Loop, 31 Jul 2014. (B) Organ Pipe headquarters, 7 May 2006. (D) Acuña Valley, 12 Mar 2015. (E) Western Puerto Blanco Mts, near Puerto Blanco Drive, 15 Mar 2015.

Fagonia longipes replaces *F. laevis* in the eastern margin of Cabeza Prieta and in Organ Pipe—at the western margin of the Arizona Upland vegetation region of Shreve (1951).

Mojave and Sonoran deserts in western Arizona, northwestern Sonora, southeastern California, southern Nevada, and southwestern Utah.

OP: Senita Pass, 8 Apr 1941, *McDougall 51.* 3 mi W of Dripping Springs, *Steenbergh 3 Mar 1962* (ORPI). Quitobaquito, 29 Mar 1988, *Felger 88-131* (ARIZ, DES, UCR). E end of Quitobaquito Hills, 24 Oct 1990, *Felger 90-485.* Red Tanks Wash, Puerto Blanco Mts, 21 Sep 2013, *Rutman 20130921-3.*

CP: Agua Dulce Pass, 13 Jun 1992, *Felger 92-572.* "B" Canyon, 32.06938ºN, 113.2026ºW, 1 Nov 1992, *Harlan 354.* Charlie Bell Road 1.9 km NE of Little Tule Well, 5 Mar 1994, *Felger 94-30.*

Fagonia pachyacantha Rydberg
[*F. californica* var. *glutinosa* Pringle ex Vail]
Thick-leaf fagonia. Figure 38.

Figure 38. *Fagonia pachyacantha.* Sierra el Águila, near Mex Hwy 2 at km 93, Sonora, 7 Mar 2015.

Low, spreading perennials, often forming semi-prostrate mats to 1–1.5+ m across during favorable times. New growth with golden-yellow glands (rarely glabrous or glabrate during times of

high rainfall); leaves bright yellowish-green, often glabrate with age. Leaflets lanceolate, ovate, obovate, or elliptic, often becoming semi-succulent during favorable seasons, the middle leaflet 1.5–2.5 × 0.5–1.2 cm, the lateral leaflets usually smaller; leaflet tips obtuse to acute, and not spinose. Stipular spines straight, at least some on each plant 5–12+ mm long, often stout, and with age bending downward toward the stem but not curved. Flowers often 1.5 cm wide. Pedicels 1.5–5+ mm long. Capsules glandular. Seeds dark brown, 2.6–2.7 × 1.9–2 mm.

Arid, rocky slopes of canyons, hills, and mountains, bajadas, and occasionally on sand flats; western half of Cabeza Prieta and the Tinajas Altas Region.

Southwestern Arizona, southeastern California, Baja California, Baja California Sur, and northwestern Sonora. Plants of *F. pachyacantha* are generally larger and more robust than those of *F. laevis* and *F. longipes*.

CP: Davidson Canyon, Agua Dulce Mts, 8 Apr 1979, *Lehto 23598* (ARIZ, ASU). Near Pinta Sands, 17 Mar 1992, *Yeatts 3253* (CAB). Senita Tank, 27 Feb 1993, *Felger 93-169*. Cabeza Prieta Peak, 2550 ft, S facing side of summit, 24 Mar 1995, *Yeatts 3662*.
TA: Tinajas Altas Mts, 1200 ft, *Lindquist 25 Mar 1983*.

Kallstroemia – Summer poppy

Summer ephemerals with pinnate leaves, the plants highly variable in size. Leaves opposite or occasionally alternate at the first several nodes of seedlings; leaves pinnate with 2–10 leaflet pairs, those of each pair often of different sizes or sometimes one aborts, those of the lowermost pair often markedly different. Stipules slender and green. Flowers opening shortly after sunrise and withering later in the day (except in cool weather). Nectaries present in the center of the flower at the stamen bases. Petals yellow or orange. Pollen and stigmas maturing simultaneously and capable of self-pollination. Fruits with 5 carpels, each divided by a septum to form half-carpel segments (mericarps); fruits breaking into ten mericarps, these 1-seeded, knobby (tuberculate) but not spiny, and falling away from the persistent axis and beak; the beak formed from the persistent style.

New World, dry tropical to arid regions; 17 species, 3 in the Sonoran Desert. This is the largest genus of Zygophyllaceae in the New World. *Kallstroemia* has been present in the flora region for more than 29,000 years.

1. Petals yellow to yellow-orange, of a single color, 4–6 mm long; sepals usually deciduous; beak of fruit less than 5 mm long; fruiting pedicels 1–2.3 cm long..... **Kallstroemia californica**
1. Petals bright orange with a darker base, (15) 20–35 mm long; sepals persistent; beak of fruit (5) 8–12 mm long; fruiting pedicels (2) 3–7 cm long..... **Kallstroemia grandiflora**

Kallstroemia californica (S. Watson) Vail
Baiburín, mal de ojo. Figure 39.

Stems generally trailing, often 20–50 cm long, sometimes to 1 m. Plants pubescent (strigose) or glabrate or glabrous especially with age. Leaves 2–4.5 (6) cm long, with 3–6 (7) pairs of leaflets. Petals 4–6 mm long, yellow to yellow-orange and of a single color. Fruiting pedicels often 1–2.3 cm long. Body of fruit ovoid, 4–5 mm long, the beak usually shorter than to about as long as the body.

Widespread across the desert lowlands, especially washes, sand flats, and dunes.

Southeastern California and southern and western Arizona to western Texas, southern Nevada and southern Utah, and northern Mexico including both states of Baja California Sur and southward to Nayarit and Zacatecas.

OP: Growler Valley, 2 Nov 1951, *Supernaugh 452.* Armenta Well Ranch, 13 Sep 1978, *Bowers 1529.* Aguajita Wash, 14 Sep 1988, *Felger 88-411.*

CP: Daniels Arroyo at Charlie Bell Rd, 18 Aug 1992, *Felger 92-674* (ARIZ, ASU). N of Jose Juan Tank, 15 Sep 1992, *Felger 92-738.* East Pinta Sands, 15 Sep 1992, *Felger 92-762.* Small wash near hills N of Agua Dulce Mts, along the Camino del Diablo, 6.6 mi W of Organ Pipe/Cabeza Prieta boundary, 26 Sep 2013, *Rutman 20130926-18.*

TA: Coyote Water, 25 Oct 2004, *Felger 04-47*

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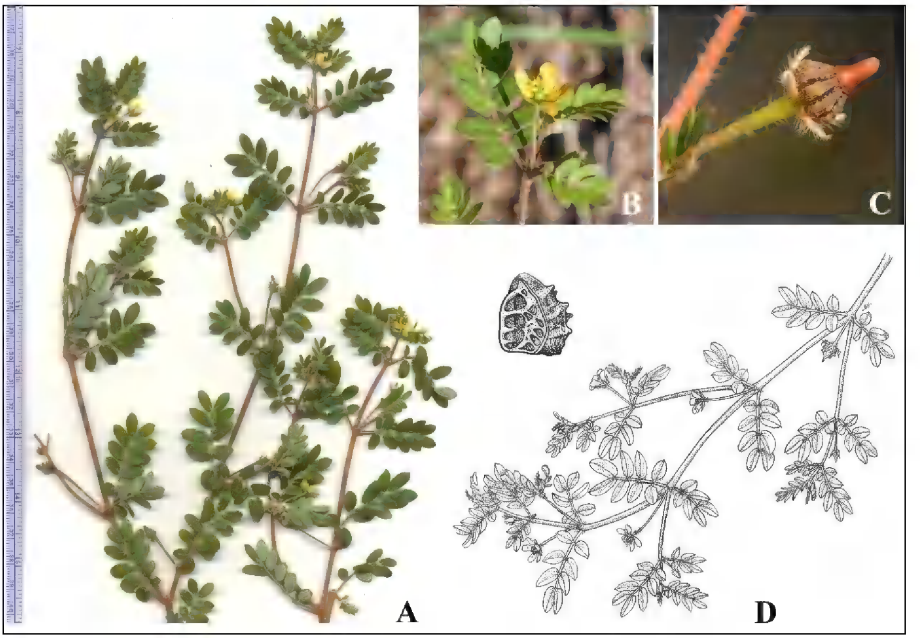

Figure 39. *Kallstroemia californica.* (A) Sandy soil near N boundary of Organ Pipe, 17 Sep 2013. (B) La Abra Plain, 12 Sep 2006. (C) S of Punta Bufeo, Baja California, 18 Oct 2006, photo by Patrick Alexander (SEINet). (D) By Lucretia Breazeale Hamilton.

Kallstroemia grandiflora Torrey ex A. Gray
Summer poppy; *baiburín, mal de ojo.* Figure 40.

Stems variously ascending, spreading or ultimately trailing with upturned tips, 15–100 (150) cm long; with soft to bristly hairs. Leaves 4.5–12 cm long, with 5–9 pairs of leaflets. Sepals green in bud, becoming pale orange after the flowers open. Flowers showy, opening about an hour after dawn and fading by mid-afternoon (or remaining open all day on cloudy days). Nectaries greenish; ants and a variety of flying insects eagerly feed at the nectaries. Corollas (3) 5–7 cm wide, orange with high color saturation; fading to pale yellow-orange or sometimes whitish usually by mid-afternoon. Corolla center and filaments dark orange-red (darker than the rest of the corolla); individual petals often (15) 20–35 mm long and 2–3.6 cm wide. Anthers yellow, often open by 8 a.m. Ovary and style green. Fruiting pedicels (2) 3–7 cm long. Body of fruits 4–5+ mm long and knobby; fruiting beak (5) 8–12 mm long (or as short as 5 mm when drought stressed).

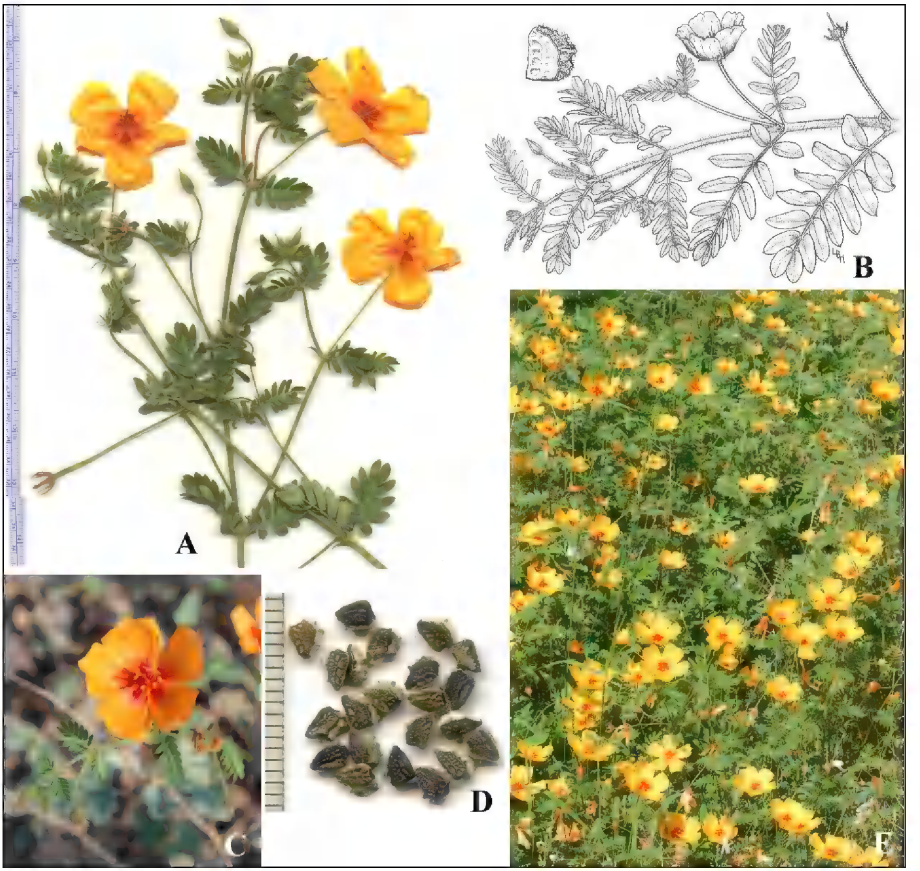

Figure 40. *Kallstroemia grandiflora*. (A) N boundary of Organ Pipe, 17 Sep 2013. (B) By Lucretia Breazeale Hamilton. (C) Hwy 85 at mile 20, 6 Sep 2013. (D) Why, 23 Aug 2014. (E) Hwy 86, mile marker 62, E of Why, 20 Aug 2006.

One of the most common and attractive summer wildflowers across the desert lowlands in Organ Pipe and Cabeza Prieta, especially larger washes, arroyo bottoms, playas, roadsides, alluvial flats, sand flats, and also on slopes; sometimes carpeting the desert with orange. Plants on dunes and sand soils can become exceptionally large in seasons with generous rains.

Southeastern California and southern Arizona to western Texas and Mexico southward Oaxaca; not known from the Baja California Peninsula. The name "summer poppy" often applied to this summer wildflower is unfortunate because it is not a poppy (Papaveraceae).

OP: Armenta Well, 13 Sep 1978, *Bowers 1528*. Ambrosia flats, T18S, R5W, sec 14, 18 Aug 1988, *Baker 7618* (ORPI). Growler Wash, *Wirt 2 Aug 1990* (ORPI). Cuerda de Leña near N boundary, *Rutman 20 Aug 2001* (ORPI).

CP: San Cristobal Wash, 14 Sep 1992, *Felger 92-686.* Sand over lava, E side Pinacate flow, 28 Nov 2001, *Felger*, observation.

†**Kallstroemia** sp./spp.

One or more species have been in the area for more than 29,000 years.

OP: †Alamo Canyon, seeds, 1150 to 29,110 ybp (5 samples). Montezuma's Head, seeds, 13,500 & 20,490 ybp. Puerto Blanco Mts, fruit fragments, 1910 & 3400 ybp.

Larrea

Shrubs. Leaves with 2–17 leaflets. Five species, 4 in South America and 1 in North America. *Larrea* is South American in origin and the single most widespread woody genus across the major warm deserts of the New World in Argentina, Chile, Bolivia, Peru, Mexico, and southwestern United States (e.g., Laport et al. 2012; Lia et al. 2001; Mabry et al. 1977; Porter 2016).

Larrea tridentata (Sessé & Moçiño ex de Candolle) Coville var. **tridentata**
[*L. divaricata* Cavanilles subsp. *tridentata* (Sessé & Moçiño ex de Candolle) Felger & C.H. Lowe]
Creosotebush; *hediondilla*, *gobernadora*; segai, segoi. Figures 41 & 42.

Highly aromatic and long-lived multiple-stemmed, trunkless shrubs often 0.8–2+ m tall with very hard, brittle wood. Stems slender, the nodes swollen with dark rings or bands formed of resin secreted by the inner surfaces of the stipules. Young stems and leaves with white hairs, the hairs soon submerged in gummy, varnish-like glandular exudate, the exudate especially thick and viscid during dry seasons. (Also see *Ambrosia deltoidea* and *Baccharis sarothroides*, Asteraceae, which show a somewhat similar pattern of hairs holding or "trapping" gummy exudate and "drowning" in the exudate.)

Leaves opposite, 5–12 mm long, subsessile or with short petioles, and 2 sessile leaflets, each more or less lanceolate to broadly ovate, moderately curved (falcate), and united at their broad bases (appearing as one simple leaf). Stipules 1.2–2.2 mm long, persistent after the leaves fall; broadly triangular-lanceolate to ovate-triangular or sometimes orbicular, with an acute to narrowly obtuse, short-acuminate tip; cordate at the base and often overlapping and tightly appressed to the stem (appearing stuck to the stem by the sticky glandular exudate) to somewhat spreading. Glands on the inner (adaxial) surface of the stipules secrete resin, making the plants highly glutinous. Youngest stipules at the growing stem tips are green, clasping, leafy-glandular organs protecting the enclosed apical meristem and are more viscid than the emerging leaf pair. These young green stipules soon become yellow and then red-brown, gland-like, and covered with resin.

Fresh flowers 2.5–3 cm wide. Sepals 5. Petals 5, separate, narrowed below to a claw, the claw often twisted and the petal blades held perpendicular to the flower axis like propeller blades. Petals, stamens, and filament scales bright yellow; sepals and style green. Stamens 10, at first often spreading or hanging down between the petals, soon standing up with the anthers close together; filaments each with a prominent yellow scale or appendage, these serving to contain nectar produced at the base of the style. Style at first equaling the stamens, with age projecting beyond them. Ovary and fruits covered with silky white hairs; capsules obovoid, appearing as small fuzzy white balls with 5 mericarps tardily separating or remaining together; mericarps (5) 6–8 (10) mm long, 1-seeded, densely hairy, often becoming reddish brown with age (Figure 41 & 42). Seeds 3.6–5 mm long, dark brown to blackish, and sometimes green, and not producing mucilage (Figure 41).

To germinate the seeds for growing purposes, Sue Rutman and associates at Organ Pipe soaked the seeds within the mericarps in water for 24–48 hours, changing the water several times. The water turned rusty brown. Radicals began to emerge at about 24–36 hours. After the seedlings

were about 10 days old, there would be some die-off, and other growers have reported similar die-off. Soil fungi are important to *Larrea,* and Sue suspects the seedlings did not make a mycorrhizal association and could not survive without it. For this reason, Sue grew the plants with native, not sterilized, soil. *Larrea* are sensitive to root disturbance. When taking them out of nursery pots to plant in the field, it was important to make sure the root ball did not fall apart. If the root ball collapsed, the plant would surely die. Also see Barbour (1968) and Cagiwa et al. (2005).

Figure 41. *Larrea tridentata.* Mericarps (A) and seeds (B), Boulder Canyon, 30 Sep 2014.

Along with the common species of *Ambrosia*, *Larrea* is one of the most abundant and widespread shrubs in the flora area. It extends across the desert floor and hills and rocky slopes to summit elevations of all but the highest peaks such as in the Ajo Mountains.

Larrea tridentata is the most widespread shrub in the three major warm deserts of North America and one of the primary elements in mapping or defining these deserts. The similar-appearing *L. divaricata* occupies deserts in South America. The dune creosotebush, *Larrea tridentata* var. *arenaria* L.D. Benson [*L. divaricata* subsp. *tridentata* var. *arenaria* (L.D. Benson) Felger] occurs on wind blown sands and dunes in the Gran Desierto nearly adjacent to the present flora area and also in southeastern California and northwestern Baja California (e.g., Felger 2000; Laport et al. 2012).

Creosotebush is the most important and universal medicinal plant in the flora area and nearby regions and its highly aromatic herbage continues to be extensively employed: "The Desert Smells Like Rain" (Nabhan 1982). It is likewise an important medicinal plant in other regions. The herbage has been used in childbirth and to treat many conditions, including congestion, sore eyes, snake and spider bites, and scorpion stings (Bean & Saubel 1972; Betty Melvin in Bell et al. 1980; Castetter & Underhill 1935; Felger & Moser 1985; Kearney & Peebles 1960; Moerman 1998, 2003; Nabhan 1982; Rea 1997 Betty Melvin in Zepeda 1985).

"If you have a sore, you boil it and wash with it . . . the leaves, all that is green, and then you put it on (like a plaster). That is the way my grandmother used to do it . . . the leaves, the brand new ones, and they would put it on a sore. I've seen it when they boil it. My cousin . . . one time he started bleeding from the nose. . . he almost died from it . . . after he left the doctor he started bleeding again and so he went home to Phoenix and got some of that creosote and he drank it and washed and washed with it and after awhile he forgot about it and it was all well . . . and then . . . he had a pain in his stomach. Some kind of infection the doctor said and again he drank the creosote and he got all

better. . . . But now the White People have gotten it now, that creosote, because it is good for many things" (Betty Melvin in Zepeda 1985: 81; also in Felger 2007).

The wood is very hard, and its uses include arrow foreshafts and arrows for small game hunting (both with a fire-hardened tip), basketry awls, crosspieces of saguaro fruit-gathering poles, drills for the firedrill, rope twisters (for horsehair and/or mesquite-root twine), and tool handles. The leafy branches were used for roofing and to cover the sides of the traditional O'odham "grass houses" (Miguel Velasco in Zepeda 1985: 23). A dark reddish lac, from the scale insect *Tachardiella larreae*, is sometimes found on the stems. This lac is plastic when heated and served as an important all-purpose sealant for sealing pottery vessels for food storage and hafting arrows; it was also was used for medicinal purposes (e.g., Felger 2007; Felger & Moser 1985; Kondo & Gullan 2011).

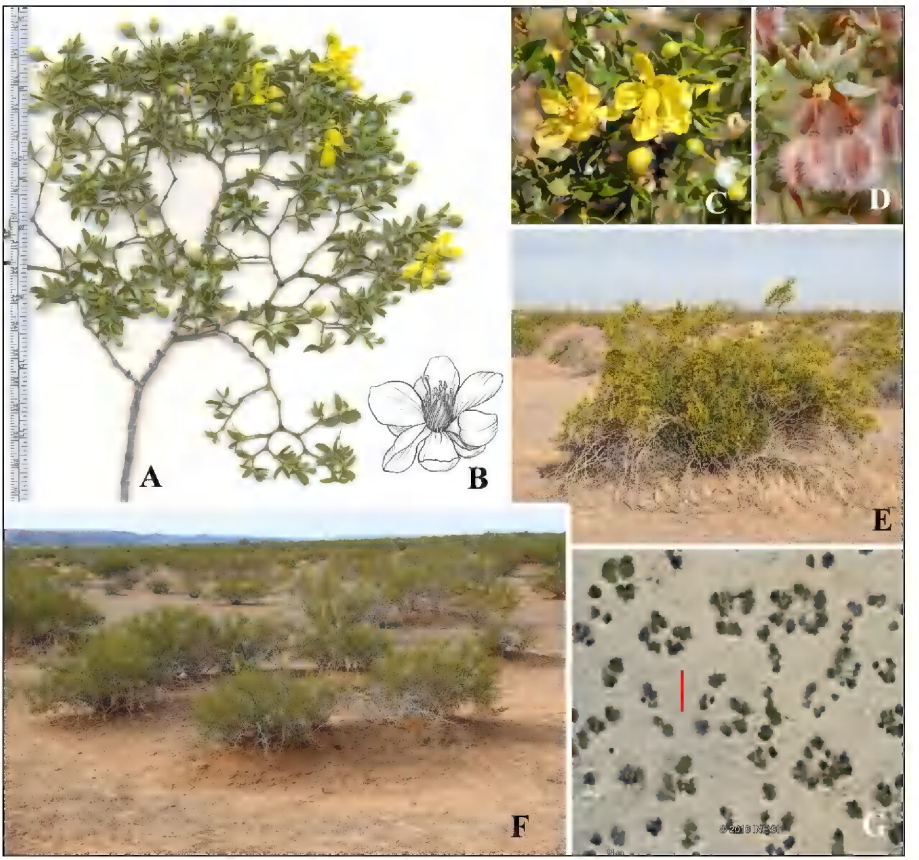

Figure 41. *Larrea tridentata*. (A) N boundary of Organ Pipe, E of Hwy 85, 7 Mar 2008. (B) By Lucretia Breazeale Hamilton. (C) Little Ajo Mts, 27 Mar 2005. (D) Ajo, 7 Jul 2006. (E) Growler Valley, 25 Apr 2006. (F) Daniels Valley, 5 Dec 2014. (G) Valley of the Ajo, E of Bates Mts, Google Earth imagery by Digital Globe, scale 1:527m, Oct 2013; red bar = 5 m, note the clonal "fairy ring" pattern of several of the plant clusters.

There has been controversy over the taxonomic rank of the North American *Larrea.* Most botanists confine *L. divaricata* to South America and call the North American plants *L. tridentata.* Morphologic (Porter 1963) and molecular (Lia et al. 2001) data confirm that they are closely related. Because of their similarities, Felger treated the North American population as *L. divaricata* subsp. *tridentata* (Felger 2000; Felger & Lowe 1976; see discussion below). Although a case could be made for recognizing the *tridentata* taxon either as a subspecies or distinct species (e.g., Laport et al. 2012), current consensus leans towards recognizing the two taxa as separate species (e.g., Porter 2016).

Most *Larrea divaricata* from South America have obtuse to somewhat orbicular stipules whereas the North American populations tend to have acuminate stipules. Hybrids between them have stipules of intermediate morphology, as does *L. divaricata* from Peru. South American creosotebushes are diploid ($2n = 26$) and North American creosotebushes include three chromosome races: diploid, $2n = 26$ in the Chihuahuan Desert; tetraploid, $2n = 52$ in the Sonoran Desert; and hexaploid, $2n = 78$ in the Mojave Desert. Among the North American chromosome races there is some overlap and no discernable morphological differences apart from stomatal size correlated with ploidy (Hunter et al. 2001).

Differences in leaflet shape and pubescence for North and South American populations have been reported, but the full span of this variation occurs in the current flora area and seems to be influenced at least in part by environmental conditions. The variation in stipule shape seems to be the "best" morphological feature by which the North and South American populations can realistically be distinguished. These resin-producing organs undoubtedly have played a significant role in the success of *Larrea* in aridlands with intense herbivore pressure. It seems reasonable to attach taxonomic and evolutionary importance to these structures.

Some botanical taxonomic intrigue and history is repeated here. In 1970, Richard and his major professor Charles Lowe changed the taxonomic rank of *Larrea tridentata* to a subspecies of *L. divaricata,* a seemingly logical course of action. Lowe knew that members of the International Biological Program (IBP) were planning to publish a similar taxonomic change, but in Lowe's opinion, he and Richard had come up with the idea first and he encouraged Richard to rush into print with the nomenclature change. Having done so much work on *Larrea,* the IBP group was obviously annoyed. Several years later, after presenting detailed analyses, various authors of the IBP group (Mabry et al. 1977) concluded that *L. divaricata* and *L. tridentata* are "semispecies" but resisted the subspecific status (also see Felger 2000).

Some people wonder how *Larrea* got from South America to North America, but this one case of intercontinental disjunction is no more amazing than many others (e.g., Bray 1898; Porter 1974; Solbrig 1972). Although many of the North and South American intercontinental disjuncts are small, sticky-seeded herbaceous plants (e.g., *Fagonia* and various Polemoniaceae), others have larger, non-sticky seeds comparable in size to those of *Larrea* (e.g., *Atamisquea emarginata*, Capparaceae).

OP: Alamo Canyon, *Nichol 26 Mar 1939.* Quitobaquito, 14 Sep 1988, *Felger 88-467.* 2 mi NW of Lukeville, 19 Jun 1989, *Felger 89-226.*

CP: Papago Well: 11 Apr 1978, *Lehto 22496* (ASU); 24 Mar 2010, *Felger 10-108* (ARIZ, ASU). Cabeza Prieta Peak, 2550 ft, N side of summit, 24 Mar 1995, *Yeatts 3657.* Sierra Pinta, summit, 15 Nov 2003, *James Cain*, photo.

TA: Camino del Diablo, SE of Raven Butte, 25 Oct 2004, *Felger 04-17.* Tinajas Altas, 22 Nov 2008, *Felger 08-187.* †Butler Mts, twigs, leaves, fruits, 740 to 11,250 ybp (7 samples). †Tinajas Altas, twigs, leaves, fruits, 4010 to 18,700 ybp (10 samples).

*__Tribulus__ – Caltrop

Herbaceous annuals and perennials. Native to the Old World, mostly Africa and southwestern Asia; 25 species.

*__Tribulus terrestris__ Linnaeus

Puncture vine, goathead, caltrop; *torito, toboso.* Figure 43.

Hot-weather ephemerals with sprawling, prostrate stems. Leaves pinnate, 1–4.5 cm long, with 4–7 leaflet pairs, the leaflets of the lower pair unequal in size. Flowers yellow, the petals 5 mm long or less, with 5 glands between the stamens at the base of the ovary. Ovary with 5 carpels. Fruits 15–18 mm wide, horizontally flattened, at maturity breaking into 5 intricately sculptured spiny mericarps (or fewer by abortion), each with (1) 2 larger tack-like spines, which invariably land with the largest spine pointed up.

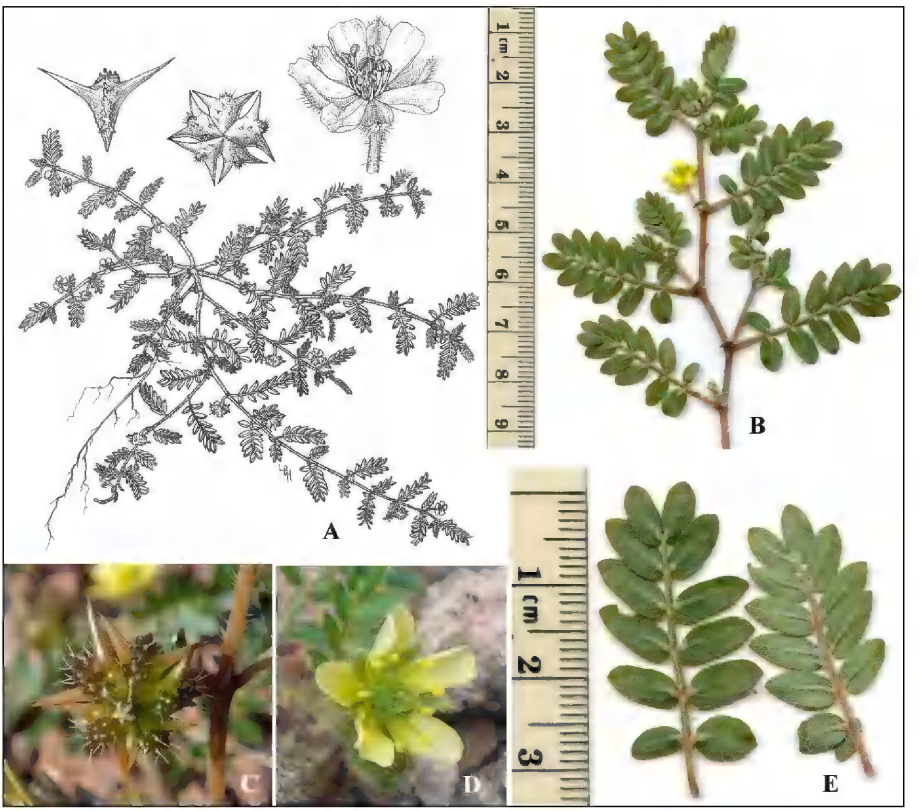

Figure 43. *Tribulus terrestris.* (A) By Lucretia Breazeale Hamilton. (B & E) Why, 31 Jul 2014. (C) San Carlos, Sonora, 10 Mar 2015, photo by Sue Carnahan. (D) San Pedro Riparian National Conservation Area, 9 Sep 2006, photo by Liz Makings (SEINet).

Occasional in the flora area and apparently not established although it is common in adjacent disturbed areas. We predict that it will become established in the flora area.

Native to the Old World, now naturalized and weedy worldwide.

CP: Tule Desert, Silt Valley, 3 Oct 1963, *Simmons 7.*

ACKNOWLEDGEMENTS

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A NEW ENDEMIC HEDGENETTLE (*STACHYS*: LAMIACEAE) FROM TENNESSEE

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ABSTRACT

Stachys glandulosissima Floden, **sp. nov.**, is described and illustrated. This species is distinct from its congeners based on a combination of characters: long petiolate leaves, sparsely distributed spreading to erect leaf indumentum, scattered pustulate-based stem-angle trichomes, the absence of eglandular pubescence on the stem faces, dense atomiferous glands on all surfaces, minimal presence of eglandular inflorescence indumentum, and elongate inflorescences. Morphologically this species is most similar to *S. eplingii* and *S. iltisii,* although it is superficially similar to *S. nuttallii.* A revised key to *Stachys* in Tennessee matches the current circumscription of species recognized in southeastern North America.

Stachys L. (Lamiaceae) is a large genus that contains an estimated 300 species (Nelson 2008; Mabberly 1997). In North America north of Mexico, there are ca. 46 species with the concentration of diversity in the mountains of the west (Mulligan & Munro 1989). The synopsis of the North American species by Mulligan and Munro (1989) is the most recent comprehensive treatment. *Stachys* in southeastern North America has received a great deal of attention in both nomenclature and taxonomy since Epling (1934) and Nelson (1981) provided overviews of the regional taxa.

Approximately 20 species of *Stachys* exist in the Southeast with a center of diversity in and around the Southern Appalachians (Nelson 2008). Despite considerable taxonomic attention there are difficulties in determination of some collections using the available floristic keys (Nelson 2008; Poindexter & Nelson 2011; Weakley 2015). Keys based on different characters can arrive at starkly different conclusions; e.g. starting with calyx lobe characters can lead to a different species than keying the same plant beginning with a key based on petiole lengths (Nelson 2008). This problem is partly due to the variation in some character states and partly because some species have been broadly circumscribed, e.g. *S. nuttallii* Shuttlew. ex Benth.

The taxonomy of *Stachys* in southeastern North America is not only taxonomically difficult because of morphological variability but also because of recent descriptions of cryptic, narrowly endemic species without clarification of the distribution or habitat of more broadly distributed species. Problems have arisen due to (1) differences of interpretation in the morphological breadth of species, (2) re-elevation or description of novel species without re-consultation of type concepts, and (3) and inclusion of misidentified species in floristic works. For instance, *S. nuttallii* was argued to be the correct name with *S. cordata* Riddell, *S. subcordata* Rydb., and *S. salvioides* Small as synonyms (Nelson 1981). Conversely, Pringle (2002) argued that *S. cordata* is the name with priority for that same conglomeration of synonyms. Current treatments by Nelson (2008), Poindexter & Nelson (2011), Fleming et al. (2015), and Weakley (2015) have recognized *S. cordata*, *S. nuttallii,* and *S. subcordata* as distinct species with only *S. salvioides* treated as a synonym of *S. nuttallii*. *Stachys eplingii* J. Nels., described by Nelson and Fairey (1979), is sympatric with *S. nuttallii* but is morphologically distinct and occurs in wet to boggy places. More recently, Nelson (2008) described *S. iltisii* J. Nelson from the Interior Highlands of Arkansas and Oklahoma, which was formerly included within a broad morphologic circumscription of the Ozark-Appalachian disjunct *S. eplingii*. Though recent recognition of *S. subcordata* as distinct from *S. nuttallii* (Nelson 2008) clarifies its

distribution as endemic to high elevations in Virginia (Fleming et al. 2011), the distributions and habitat preferences for *S. cordata* and *S. nuttallii* have not been elucidated. Fleming et al. (2011) described an additional species, *S. matthewsii* Fleming, Nelson, & Townsend, which was compared to *S. hispida* Pursh, *S. latidens* Small, *S. cordata*, and *S. nuttallii*. Many of these recently described species are narrow endemics within and around the Southern Appalachian Mountains.

Despite reports of *Stachys eplingii* in Tennessee (Chester et al. 1997), the most recent account of *Stachys* in Tennessee excludes *S. eplingii* based on communications with J.B. Nelson (Chester et al. 2009). Reports of *S. eplingii* in Tennessee, including that of Mulligan and Munro (1989), have referred to a few populations from Polk County; a disjunction several hundred kilometers from its distribution in West Virginia and Virginia. Mulligan and Munro (1989) reported this species and provided a chromosome count for the species from Tennessee. Thus, the exclusion of *S. eplingii* from Tennessee leaves the placement of these unusual plants from Polk County without a sustainable assignment within a recognized species and the chromosome number of *S. eplingii* undocumented. Attempts at keying these plants in relevant literature (Nelson 2008; Poindexter & Nelson 2011; Weakley 2015) result in the placement of these plants in either *S. nuttallii* or *S. cordata* because of their long petioles. However, these Polk County populations differ from both species in their predominantly and densely distributed atomiferous glandular indument, minimal presence of eglandular indument (which is restricted to leaf surfaces, stem angles, and scattered on the calyces), and their leaf shape. Elongate inflorescences and dense glandular indument throughout the plant suggests a close relationship to *S. eplingii* and *S. iltisii*. The presence of pustulate based trichomes on the stem angles and the elliptic-oblong leaves are more similar to *S. nuttallii* than they are to *S. cordata*, which has broadly ovate leaves with pubescent stem faces and angles. Based on their distinctive combination of morphological traits, the Polk County plants are determined here to represent a distinct species confined to the Walden Creek geologic formation (see Hardeman 1966) along the Hiwassee River of Polk County.

Stachys glandulosissima A. Floden, **sp. nov.** (Figure 1). **TYPE**: **USA**. **Tennessee**. Polk Co.: Junction of Hwy 30 and 315, just W of stop sign on bluff slope and in ditch, abundant, 15 Jul 2011, *A. Floden 1603* (holotype: TENN; isotypes: APSC, BRIT, MO, NCU, NY, SC).

Stachys glandulosissima is similar in appearance to *S. nuttallii* Shuttlw. ex Benth. with pustulate-based spreading trichomes on the stem angles but differs in its vestiture consisting of short, stipitate-glandular trichomes covering all surfaces, like those of *S. eplingii* J. Nels. The new species differs from *S. eplingii* in its long-petiolate leaves (vs. sessile or subsessile).

Perennials herbs, 5–20, or more stems per plant; rhizomes white, cylindric tubers 1–6 mm long present at ends of new rhizomes; stems to 60–100 cm, erect, rarely branched, stem angles with uniseriate 2–4-celled retrorse to spreading pustulate-based trichomes, 1–5 mm long, sides and angles with copious short stipitate glandular trichomes, foliar internodes 4–8 cm long; leaves petiolate, petioles 1–8 cm long, midstem petioles longest, margins densely shortly stipitate glandular and with pustulate-based trichomes to 1–4 mm long; leaf blades ovate-elliptic, apex long-acuminate, base cordate on lower stem to rounded-truncate above, 7–21 x 3–8 cm, both surfaces copiously shortly stipitate glandular with interspersed longer trichomes with pustulate bases confined to veins, margins crenate to serrate; inflorescences elongate, the lower verticils well separated, the upper more dense, internodes 0.3–3 cm; cymules 1–3-flowered, verticils 4–6-flowered; inflorescence leaves greatly reduced, ovate, margins ciliate, faces densely short stipitate glandular; calyces 5–7 mm long, tube 3.5–5 mm long, lobes narrowly deltoid, 1.5–2 mm, apices cuspidate-acuminate with a reddish spinose tip ca. 0.25–0.5 mm long, calyx 2–3 mm wide at mouth, narrowly-campanulate, densely short stipitate glandular, with sparse longer non-glandular trichomes, margins with longer capitate glandular trichomes; pedicels 1–1.5 mm, corollas white to pale pink with darker reddish maculation,

6–8 mm, lower lip at 90 degree angle, 3-lobed, surface pubescent-glandular, filaments with longer trichomes proximally mixed with shorter stipitate glandular trichomes to middle and distally with dense short stipitate glandular trichomes; mericarps ovoid, 1.5–2 mm, castaneous.

Cytology. Specimens of *Stachys glandulosissima*, included within *S. eplingii* by Mulligan & Munro (1989), were reported as $2n = 34$ from near where *Floden 1604* was collected (see below).

Distribution. **Tennessee**. Polk Co.: Hiwassee River talus slopes with underlying seepage moisture or along smaller drainages. This species only occurs on a small portion of the south side of the river within the confines of the Walden Creek geologic formation. Fieldwork through 2009–2012 led to the discovery of populations only on the south side of the Hiwassee River on north-facing slopes.

Phenology. Flowering late May-July, fruiting July-August.

Other specimens examined. Tennessee. Polk Co.: Hwy 30, ca. 1 mi W of 315 junction on S side of road on N-facing slope, shale substrate, 35 11.964, -84 30.683, 17 May 2012, *Floden 2130* (APSC, MO, TENN) and 5 Jun 2009, *Floden 904* (APSC, MO, TENN); Hwy 30 ca. 1.25–1.5 mi W of jct with 315, along small creek on roadside, N and S sides of road, 15 Jun 2011, *Floden 1604* (APSC, MO, TENN).

The closest relationships of *Stachys glandulosissima* seems to be with *Stachys eplingii* and *S. iltisii* with which it shares numerous morphological features. *Stachys glandulosissima* has glandular vestiture throughout, elongate inflorescences, and the calyx shape of *S. eplingii* and *S. iltisii*, but it differs from both species in the long petiolate leaves, more prominently cuspidate calyx lobes, and the presence of pustulate-based, erect, stem-angle trichomes. Additional differences are seen in the abrupt shift from the lowermost, densely pubescent internodes to densely short-stipitate glandular stem faces with a sparse distribution of pustulate-based spreading trichomes on the stem angles above, and also in the minimal presence of eglandular calyx trichomes (Figure 1g). Indument type has been shown to be of value in separating species within *Stachys* species groups but not in defining relationships among groups (Salmaki et al. 2009). Further enumerations of characters that differentiate *S. glandulosissima* from its congeners are provided in the key to *Stachys* in Tennessee below.

The habitat of *Stachys glandulosissima* is at the base of shale talus slopes with underlying moisture and differs from that of *S. eplingii*, which is reportedly in boggy places (Nelson 2008). It is also disjunct from the nearest *S. eplingii* in southwestern Virginia (though a specimen collected in Burke County, N.C., by *M.A. Curtiss s.n.* [NYBG digital image] suggests it may have historically occurred in closer proximity to this new species).

The description of another novel *Stachys* species in an area that has received considerable attention to its flora, especially in the Southern Blue Ridge, shows that despite the density of collections there still are novelties in specialized ecological communities. This and other recent discoveries emphasize the continued need for floristic surveys and fieldwork even in well explored regions.

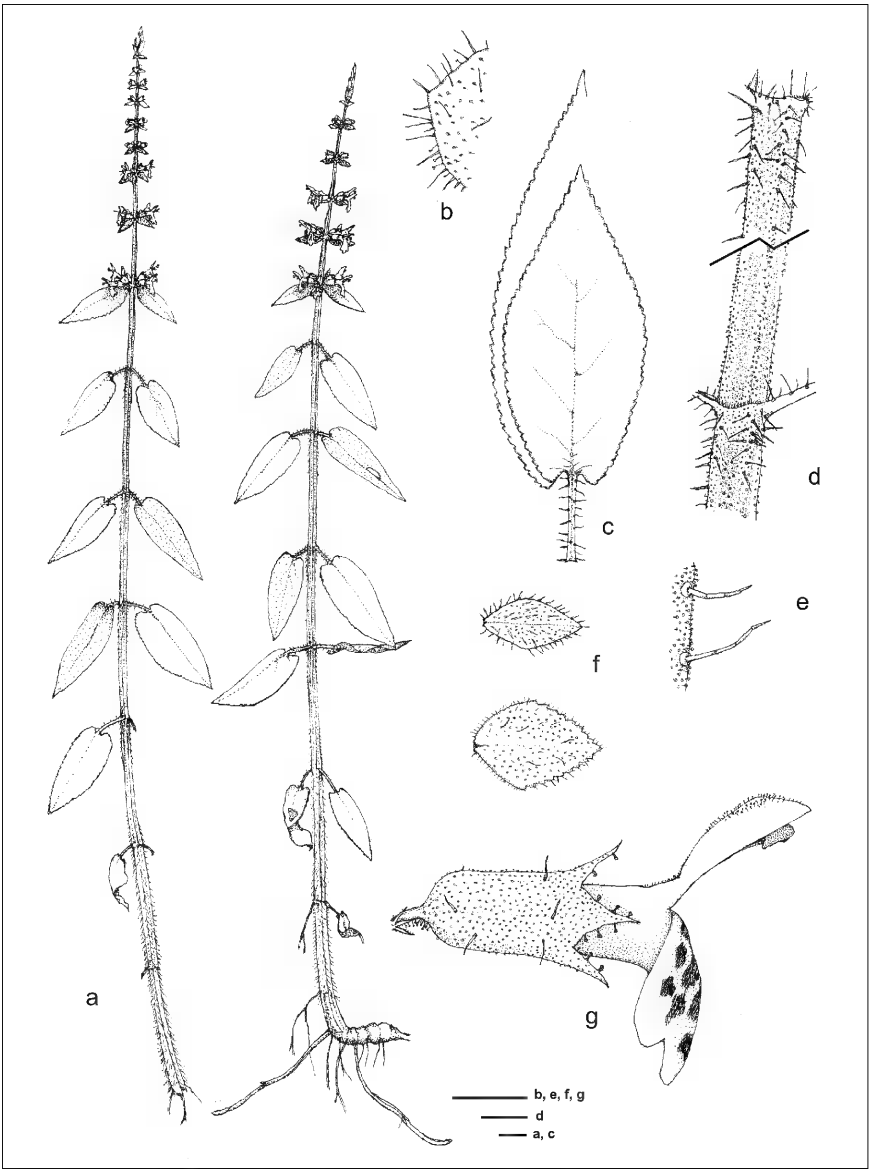

Figure 1. *Stachys glandulosissima*. A. Whole plant. B. Single serration of the leaf margin. C. Leaves showing variation in widest point of leaf and petiole D. Stem nodes and partial internodes. E. Uniseriate trichomes found on the stem angles. F. Bract leaves of the inflorescence. G. Calyx and corolla.

Measurements are as follows for their respective part of the figure: a = 2 cm; b = 0.5 mm; c = 1 cm; d = 1 cm; e = 2 mm; f = 1 cm; g = 5 mm. Drawn by the author from the type collection, *Floden 1603*.

Key to the taxa of *Stachys* in Tennessee

This key differs from the recent Flora of Tennessee (Chester et al. 2015) treatment in recognizing the synonyms of the *Stachys nuttallii*-complex as separate species following current taxonomy in the Southeast. Recent collections from northeastern-most Tennessee confirm the presence of *S. appalachiana* in the state and an additional collection of the non-native adventive *S. germanica*. *Stachys salvioides* is treated here as distinct from *S. nuttallii* and from *S. cordata*.

1. Leaves and stems densely hoary pubescent, adventive ..... **Stachys germanica**
1. Leaves and stems variously pubescent, but not hoary.

2. Rhizomes always with tubers; stem angles shortly retrorse pubescent or glabrous; leaf margins crenate; calyx lobes narrowly lanceolate; adventive ..... **Stachys floridana**
2. Rhizomes occasionally with tubers or tubers absent; stem angles variously pubescent; leaf margins various; calyx lobes deltoid to lanceolate; native.

3. Stem faces glabrous below inflorescence, angles sparsely short retrorse hispid or rarely glabrous ..... **Stachys latidens**
3. Stem faces and angles variously pubescent, but not in the above combination.

4. Petioles short, 5–15 mm long.

5. Stem faces glabrous within inflorescence, stem angles retrorse hispid pubescent especially below inflorescence; calyces with sparse eglandular trichomes mostly on lobes; flowers 6 per verticil ..... **Stachys hispida**
5. Stem faces and angles glandular pubescent; calyces glandular pubescent throughout; flowers 8–10 per verticil ..... **Stachys appalachiana**

4. Petioles long, 15–35 mm long.

6. Calyx lobes aristate, with spine-like apices 1–2 mm long.

7. Stem faces eglandular; stem angles with spreading trichomes 1–3 mm long; leaves sparingly pubescent ..... **Stachys clingmanii**
7. Stem faces copiously atomiferous glandular; stem angles with pustulate based spreading trichomes 1–3 mm long; leaves atomiferous glandular mixed with sparse eglandular trichomes ..... **Stachys glandulosissima**

6. Calyx lobes not aristate, occasionally spine-like but then <1 mm long.

8. Stem faces glabrous to glabrate below the first node subtending the inflorescence.

9. Stem angles with pustulate based stout trichomes, faces pubescent within the inflorescence; leaves hispid pubescent ..... **Stachys nuttallii**
9. Stem angles occasionally with short retrorse hairs, faces glabrous throughout; leaves usually glabrous or glabrate ..... **Stachys tenuifolia**

8. Stem faces pubescent throughout.

10. Leaves strongly cordate, lamina broadest near the base; vestiture a mix of long and short trichomes, somewhat hispid, occasionally with glandular trichomes in the inflorescence ..... **Stachys cordata**
10. Leaves cordate, lamina broadest above the middle; vestiture often densely sericeous with a mixture of longer trichomes so that the lamina is often silvery, silky even when sparse, usually stipitate glandular within the inflorescence ..... **Stachys salvioides**

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HOSTA LANCIFOLIA (LILIACEAE): A NEW GENUS AND SPECIES FOR THE ARKANSAS FLORA

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ABSTRACT

Hosta lancifolia Engl. is reported here as new (genus and species) to the naturalized Arkansas flora. Several plants of *H. lancifolia* were discovered growing on the slope of a ravine in disturbed, urban woods in Pulaski County at a site surrounded by residential areas. A photograph of the voucher specimen is provided.

Hosta is a genus of about 40–45 species of herbaceous, rhizomatous, perennial herbs of Asiatic origin, with most species native to Japan (Bailey & Bailey 1976; Chen & Boufford 2000; Utech 2002). Many species, including *H. lancifolia*, are highly regarded as ornamentals in temperate shade gardens for their showy flowers, attractive, often variegated foliage, high shade tolerance, and general ease of cultivation (Bailey 1949; Bailey & Bailey 1976; Chung & Jones 1989). Although horticultural purposes are the principal use of the genus, the leaves of some species are eaten in Japan and Korea (Utech 2002). Species delimitation in *Hosta* is problematic, because of centuries–long cultivation, along with extensive hybridization and horticultural selection. Well over 1000 cultivars have been recorded (Schmid 1991; Utech 2002).

Hosta lancifolia Engl. (narrow–leaf plantain lily) is a mounding or clumping, herbaceous perennial that reaches a height of 35–60 cm; it produces short, sometimes stoloniferous rhizomes. It is native to Japan (Utech 2002; Aniśko 2008) but is cultivated worldwide and is one of the more frequently grown species of *Hosta* in the USA (Bailey 1949; Utech 2002). *Hosta lancifolia* makes an excellent ground cover because of its dense, glossy foliage, vigorous vegetative growth, and high shade tolerance (Utech 2002; Aniśko 2008). It prefers moist, mildly acidic soils with high humus content (Aniśko 2008) but tolerates drier conditions than most other *Hosta* species and full sun exposure if soils are consistently moist (Aniśko 2008).

Hosta lancifolia has been documented outside of cultivation in a number of eastern states, including Connecticut, Maryland, Illinois, Massachusetts, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and Rhode Island (Utech 2002; Kartesz 2015; Weakley 2015; USDA, NRCS 2016). It sometimes persists subsequent to cultivation practices and may spread asexually via stoloniferous rhizomes (Utech 2002). When naturalized, it typically occurs in highly disturbed habitats, such as urban woods and green belts, roadsides, lawns, and open waste places (Mohlenbrock 1986; Rhoads & Klein 1993; Broderick 1997; Utech 2002). Escape and subsequent naturalization by *H. lancifolia* is probably exclusively accomplished via asexual means, as plants are generally sterile and rarely, if ever, develop mature fruits (Utech 2002). *Hosta lancifolia* is believed to be of garden

origin and wild populations not directly or indirectly associated with anthropogenic activities probably do not exist (Schmid 1991; Aniśko 2008).

In 2002, naturalized plants of *Hosta lancifolia* were documented on a slope of a wooded ravine in highly disturbed, urban woods in Pulaski County (Fig. 1). The site is surrounded by residential areas. Plants were reproductive with well-developed inflorescences. The precise origin of the naturalized *H. lancifolia* plants is unknown, but evidence of spread and establishment, probably via rhizomes, was evident. A second occurrence of escaped/naturalized *Hosta* from Pulaski County also was documented in 2002 (*Peck 2002120*); however, unequivocal identification to species is problematic, as the voucher specimen consists of sterile material—a single, variegated leaf.

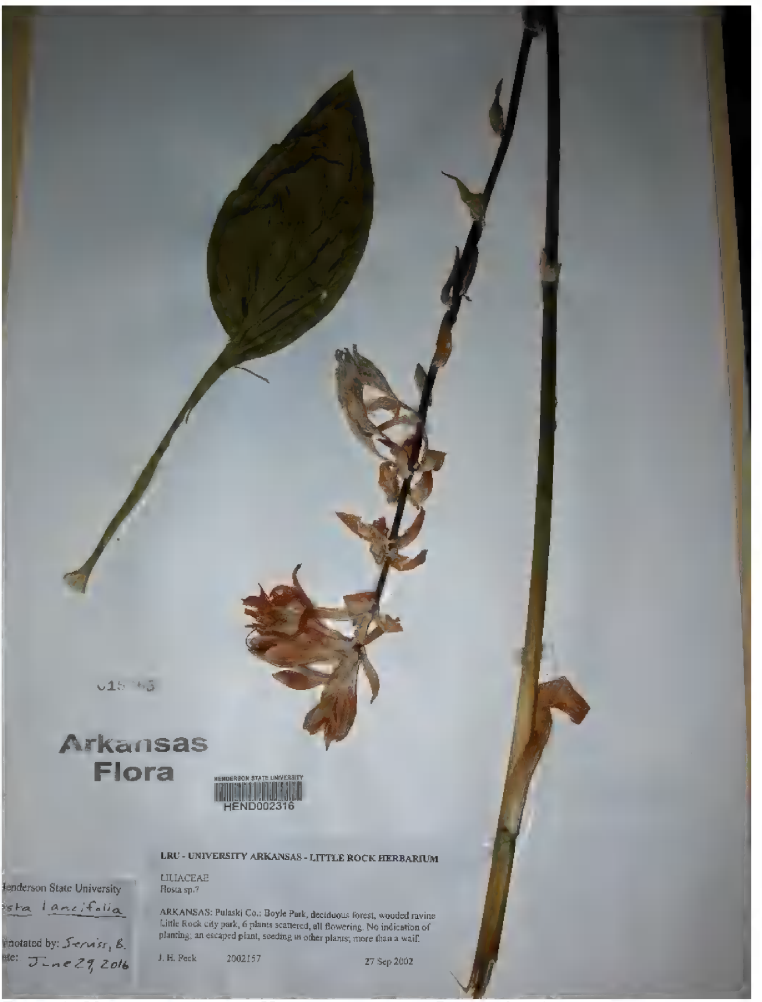
Arkansas
Flora
HENDERSON STATE UNIVERSITY
HEND002316
LRU - UNIVERSITY ARKANSAS - LITTLE ROCK HERBARIUM
LILIACEAE
Hosta sp.?
ARKANSAS: Pulaski Co.: Boyle Park, deciduous forest, wooded ravine
Little Rock city park, 6 plants scattered, all flowering. No indication of
planting, an escaped plant, seeding in other plants; more than a waif.
J. B. Peck 2002157
27 Sep 2002
Henderson State University
Hosta lancifolia
Annotated by: Serviss, B.
Date: June 29 2016

Figure 1. Voucher specimen of *Hosta lancifolia* from Pulaski Co., Arkansas.

Based on its frequency of cultivation, *Hosta lancifolia* should be expected as adventive or escaped elsewhere in Arkansas in low quality, highly disturbed environments, particularly in urban natural areas adjacent to where plants of the species are cultivated or persisting or in places where horticultural discards are deposited.

Voucher specimens. **Arkansas**. Pulaski Co.: Six plants scattered in deciduous forest along wooded ravine, all flowering, no indication of planting; an escaped plant, seeding in other plants; more than a waif, Boyle Park, Little Rock, 27 Sep 2002, *Peck 2002157* (HEND); a few plants scattered in deciduous forest on bluff above Murray Park adjacent to Arkansas River, an escaped species seeding in other plants; more than a waif, Cantrell Hill W of downtown, Little Rock, 20 Sep 2002, *Peck 2002120* (HEND).

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CASUARINA EQUISETIFOLIA (CASUARINACEAE) NATURALIZED IN TEXAS AND COMMENTS ON ECOLOGICAL IMPLICATIONS FOR THE TEXAS COAST

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ABSTRACT

Casuarina equisetifolia, Australian pine, is reported here as naturalized in Aransas, Cameron, Calhoun, Kleberg, and Nueces counties of the Gulf Coast Prairies and Marshes in the Coastal Bend (mid-coast) of Texas. It is documented as reproducing and expanding from parent stands in coastal prairies, bay shorelines, and inland dunes. Based on biogeography, ecology, and performance in its naturalized state outside of Australia, southern Asia and the Pacific archipelagos, monitoring in Texas should be considered to determine potential regional expansion and ecological threats.

Casuarina equisetifolia L. ex J.R. & G. Forst. is a member of the Casuarina or Beefwood family (Casuarinaceae), commonly known as Australian pine, whistling pine, beach she-oak or horsetail tree. The genus *Casuarina* consists of 17 species, with *C. equisetifolia* native to the tropical and subtropical coastlines of Australia and offshore islands, Malaysian and Pacific archipelagos (sensu latu), including islands of New Zealand, Polynesia, and Oceania (Morton 1980; National Research Council 1984; Orwa et al. 2009; Wilson & Johnson 1989; El-Lakany et al. 1990). Distribution is currently pantropical and expanded through intentional introduction and unintentional naturalization (National Research Council 1984; Wilson & Johnson 1989; El-Lakany et al. 1990). The species is currently known to be established from Puerto Rico (Little & Wadsworth 1964), Hawaii (Degener 1963), and Florida (Morton 1980).

Intentional introductions to Florida occurred by the late 1898 with seeds brought from France by the U.S.D.A surveyor, W.T. Swingle (Morton 1980), well known for his penchant of exotic importations (see description in Mink et al. 2015). Occurrence and establishment of naturalized stands were documented since the late 1890s and early 1900s along Florida coastal dunes (Donnelly 1921; Small 1927). Barrett (1956) discussed problems with usage of *Casuarina equisetifolia* because of its invasive growth habit and aggressive choking of indigenous vegetation, clearly recognizing a problematic transformation of the landscape in 1930s Florida. It has been widely cultivated in Florida for coastal landscaping, as an ornamental shade tree and agricultural promotion -- whether as fuelwood, timber or planted as windbreaks bordering groves. These pursuits coupled with extensive naturalization have promoted, especially in the southern half of the state, *C. equisetifolia* as a ubiquitous presence throughout coastal Florida (Morton 1980).

Although various electronic sources document or discuss *Casuarina equisetifolia* as an invasive species in Texas, these sources lack adequate documentation. The mention of this species as naturalized in Texas is based upon cultivated specimens or observations without vouchers. The three counties mapped (as species waifs) for Texas in BONAP (Kartesz 2016) are based on cultivated plants or else lack documentation: Cameron Co.: San Benito, Griffing Bros. nursery, noted as cultivated, 20 May 1915, *Tharp s.n* (TEX/LL). Galveston Co. Galveston, corner of Juniper Avenue and Oak Avenue, annotated as cultivated, Clear Lake Shores, 11 Mar 1975, *Waller & Bauml 3394* (TEX/LL). Nueces Co.: mapped based upon Invasives.org observations and locations in urbanized settings. Invasives.org lists seven occurrences of *C. equisetifolia* in Texas, five from Nueces Co. and two from Cameron Co.; none are vouchered by specimens.

The following list cites specimens collected by the authors during their research of the species in Texas.

Texas. Aransas Co.: 1.4 mi S of Bahama Rd and North Fulton Beech Rd on North Fulton Beech Rd, E side of road, growing along edge of Aransas Bay, plants reproducing, including seedling trees, 9 Jun 2009, *Singhurst 18189* (BAYLU); 0.1 mi N of jct. of Laguna Vista Drive and N Fulton Beach Rd on N Fulton Beach Rd, E side of N Fulton Beach Rd., growing along Aransas Bay shoreline, 8 Mar 2016, *Singhurst 21040* (BAYLU). Cameron Co.: Jct. Co Rd 228 and FM 1421, NW corner of junction, invading agricultural field, 8 Dec 2015, *Singhurst 21033* (BAYLU); 0.4 mi W jct. of Cavaxos Omoti Rd and New Carmon Ave on Cavaxos Omoti Rd, S side of Cavaxos Omoti Rd, invading agricultural field, 8 Dec 2015, *Singhurst 21034* (BAYLU). Calhoun Co.: Port Lavaca, Lighthouse Beach Park, along Lighthouse Beach Road, several age classes throughout Noble Point,14 Apr 2015, *Holmes, Singhurst, & Mink 16435* (BAYLU). Kleberg Co.: Padre Island National Seashore, 1 mi N of Bird Island boat ramp, along the E shore of Upper Laguna Madre (photo; Figure 4). Nueces Co.: 0.1 mi N of Park Rd 22 and Elbow Street on Park Road 22, W side of Park Rd 22, growing in coastal prairie, plants reproducing, including seedling trees, 11 Jun 2009, *Singhurst 18190* (BAYLU); 0.3 mi. E of Park Rd 22 and Viento Del Mar Road in Padre Bali Park, 12 Jun 2009, *Singhurst & Ilfrey 18192* (BAYLU); intersection of Park Rd 22 and Nemo Court, 7 Mar 2016, *Holmes, Singhurst, & Mink 16643a* (BAYLU); confluence of JFK memorial causeway and Park Rd 22, 7 Mar 2016, *Holmes, Singhurst & Mink 16643b* (BAYLU); Port Aransas, Hwy 361 along Palmilla Beach golf course, 7 Mar 2016, *Holmes, Singhurst, & Mink 16646* (BAYLU).

The *Casuarina equisetifolia* stand in Aransas County occurs along Aransas Bay where it appears to have recently arrived from nearby parent trees and is reproducing. Since our initial collection (2009), it was revisited in December 2015 and the plants were producing abundant woody, cone-like structures. During that site visit this stand was observed to have been recently stump cut (past year or two) to be eradicated. However, individuals were resprouting to 10 feet in height from the trunk bases and flowering. This small stand of *C. equisetifolia* was growing with *Avicennia germinans*, *Distichlis spicata*, *Heliotropium curassavicum*, *Hydrocotyle bonariensis*, *Lycium carolinianum*, and *Sesuvium portulacastrum*.

A stand of *Casuarina equisetifolia* at Padre Island National Seashore (PINS) in Kleberg County was brought to our attention by Charles Sassine and Alicia Walter, science staff with PINS. The National Park Service has been treating a stand of *C. equisetifolia* in an attempt to eradicate it and prevent it from expanding along the Upper Laguna Madre shoreline (Figure 4). We visited the stand and observed that about half of the stand was dead and the other half was thriving with numerous seedling trees of varying age establishing from 3 to 20 meters away from parent trees. This stand of *C. equisetifolia* was associated with a *Schizachyrium littorale-Paspalum monostachyum* dominated coastal prairie. Other flora present included *Andropogon virginicus*, *Distichlis spicata*, *Fimbristylis castanea*, *Linum* sp., *Polygala polygama*, *Rhynchospora* sp., *Spartina patens*, and *Xyris jupicai*.

The Nueces County stands of *Casuarina equisetifolia* were all reproducing and expanding at varying age classes from parent plants into coastal prairie (Figures 1-3, 5). These stands were associated with a *Schizachyrium littorale-Paspalum monostachyum* dominated coastal prairie. Other flora present included *Baptisia sphaerocarpa*, *Conoclinium betonicifolium*, *Croton capitatus*, *C. glandulosa*, *Dichanthelium acuminatum*, *Eleocharis* sp., *Heterotheca subaxillaris*, *Hydrocotyle bonariensis*, *Ilex vomitoria*, *Morella cerifera*, *Physalis cinerascens*, *Polygala polygama*, *Rayjacksonia phyllocephala*, *Sisyrinchium* sp., and *Solidago sempervirens*.

The *Casuarina equisetifolia* stands in Cameron County appear to be established as wind breaks or shade trees near entry roads into agricultural fields (Figure 6). Various age classes of *C. equisetifolia* were documented as expanding into adjacent agricultural fields. Indeed, in areas without repeated periodic disking and plowing of fields the aggressive spread and disruption of *C. equisetifolia* is evident. These stands of *C. equisetifolia* were associated with *Dichanthium annulatum*, *Pennisetum ciliare*, and *Prosposis glandulosa*.

Ecological Implications for Texas: Floral and Faunal

Casuarina equisetifolia has several life history traits that make this species particularly invasive: prolific seed production with fecund propagation (hundreds of cones per tree consisting of 40-60 seeds per cone) (Long & Lakela 1971), salt tolerance-growing even in front-line dunes (Watkins 1970), ability to fix nitrogen and thus tolerate poor soil regimes (Diem et al. 1982), drought tolerance, survive prolonged saltwater saturation and oxygen deficiencies (Orwa et al. 2009), and an ability to coppice. With rapid growth, dense shade, dense litter accumulation, and other competitive advantages, these plants displace and are destructive to native vegetation regimes (Nelson 1994).

Parrotta (1999) demonstrated in an understory successional, mixed-species plantations that *Casuarina equisetifolia* had lower plant biodiversity than either *Eucalyptus robustus or Leucana leucocephala* in Puerto Rico. Additionally, *C. equisetifolia* needles, cones, and mats of litter possess allelopathic properties which can depress germination rates and a natural herbicide that promotes species homogeneity within stands (Suresh & Vinaya 1987; Batish et al. 2001). Given their robust dissemination and propagule pressure colonizing disturbed or exposed habitats, short sub-reproductive period, accelerated growth and ability to grow substantially well at high densities make them desirable ornamentals and useful windbreaks (Rockwood & Geary 1991); however, these traits contribute to their invasive potential and hamper competitive ability of native species.

Casuarina equisetifolia may contribute to dune destabilization and encourage beach erosion by displacing deep-rooted native vegetation (Klukas 1969). Root structure and coppicing interferes with nesting areas of green and loggerhead (*Chelonia mydas, Caretta caretta*) sea turtles and American crocodiles (*Crocodylus acutus*) in Florida and Neotropical coasts (Klukas 1969; Moler 1991). Terrestrial areas of gopher tortoise (*Gopherus polyphemus*) distribution are potentially threatened by *C. equisetifolia* invasion in areas of Florida (Klukas 1969). Texas has a state-threatened tortoise (*Gopherus berlandieri*) in addition to the same species of threatened and endangered sea turtles that nest in coastal areas of Florida (Conant & Collins 1998).

Three sympatric populations of rodent species — *Oryzomys palustris*, *Peromyscus gossypinus* and *Sigmodon hispidus* –– were found to be depauperate in established *Casuarina equisetifolia* stands in Florida Everglades. Mazzotti et al. (1981) described these effects, noting an absence of reproductive animals trapped in *C. equisetifolia* habitat sample sites, low abundance of cotton mice (*P. gossypinus*), and exclusion of cotton rats (*S. hispidus*) and rice rats (*O. palustris*). Smith & Vrieze (1979) studied *C. equisetifolia* impact on faunal populations and potential detriment to their important role in the Everglades ecosystem. Davis (1943) documented *C. equisetifolia* alterations to the physiognomy of the Everglades.

The rapid establishment of *Casuarina equisetifolia* outside its native range and its fecundity, accelerated growth, salt and drought tolerance, and allelopathic toxins create an ecological threat in coastal areas of Texas. The species reduces diversity of native flora and suppresses various faunal components. The impact of this species in Texas may necessitate its removal from known areas and prevention of reestablishment. Monitoring with periodic environmental assessments and formulation of management plans may be necessary.

Figure 1. *Casuarina equisetifolia* pistillate flowers in small, axillary clusters in Nueces Co., Texas. Photo by Jason Singhurst, 8 March 2016.

Figure 2. *Casuarina equisetifolia* staminate flowers on terminal spikes in Nueces Co., Texas. Photo by Jason Singhurst, 8 March 2016.

Figure 3. *Casuarina equisetifolia* woody, cone-like fruits in Nueces Co., Texas. Photo by Jason Singhurst, 8 March 2016.

Figure 4. *Casuarina equisetifolia* reproducing after herbicide treatment, Padre Island National Seashore, Kleberg Co., Texas. Photo by Jason Singhurst, 8 March 2016.

Figure 5. *Casuarina equisetifolia*, Nueces Co., Texas. Photo by Jason Singhurst, 8 March 2016.

Figure 6. *Casuarina equisetifolia*, Cameron Co., Texas. Photo by Jason Singhurst, 8 December 2015.

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REDISCOVERY OF *TRIOSTEUM PERFOLIATUM* IN LOUISIANA

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ABSTRACT

Triosteum perfoliatum L. is an herbaceous species widespread in the midwestern and upper midwestern USA but relatively uncommon in the South. This species was previously known in Louisiana only from a single collection made in 1967 in Natchitoches Parish, which is located in the central portion of the state. This paper reports the rediscovery of this species in the general vicinity of the original collection site ca. 50 years later.

The range of *Triosteum perfoliatum* L. extends from Massachusetts south to Georgia and Alabama, west to Texas and Nebraska, and north to Minnesota (BONAP 2015; USDA plants database). However, populations of this species are most concentrated in the center of its range in the states of Kansas, Missouri, Illinois, and Wisconsin (BONAP 2015; Brooks 1986; Holmes et al. 1999; Fernald 1950; Small 1933; USDA Plants Database 2016). On the periphery of its range, especially in the southern and southeastern USA, it is much less common. In the South, *Triosteum perfoliatum* is currently reported from 2 counties in South Carolina, 8 counties in northern Georgia, 4 counties in Alabama, 1 parish in Louisiana, and 1 county in Texas (BONAP 2015; Holmes et al. 1999; Keener et al. 2016; Thieret 1967; Thomas & Allen 1996; USDA Plants Database 2016).

A specimen from Natchitoches Parish, Louisiana, collected in 1967, is one of the two southernmost locations of this species in the USA. Since the only Louisiana record is nearly 50 years old, *Triosteum perfoliatum* was ranked SH (historical) for the state (NatureServe 2015). While surveying calcareous prairies and woodlands in this region, *Triosteum perfoliatum* was rediscovered by the author in June 2016 in the vicinity of where it was originally documented by Theiret (1967; Southeastern Biota 2016). Approximately ten individuals were observed on the edges of two separate 0.5 hectare prairies in the prairie/woodland ecotone. Close associates of *Triosteum perfoliatum* at these sites include *Viburnum rufidulum*, *Viburnum dentatum*, *Crataegus marshallii*, *Crataegus spathulata*, *Fraxinus americana*, *Cornus florida*, *Cornus drummondii*, *Frangula caroliniana*, and *Diospyros virginiana*. Exploration of additional calcareous prairies and woodlands are planned for the near future.

Locating this population of *Triosteum perfoliatum* is significant since this species hasn't been observed at this location in ca. 50 years. This site is also significant in that it is possibly the southernmost location of this species. The Louisiana record of *T. perfoliatum* is ca. 225 km from the nearest known location in Anderson Co., Texas. This location is due west of the Louisiana locale. The next nearest location is to the north in Polk Co., Arkansas, ca. 333 km from the Louisiana record. The closest location to the east of the Louisiana locale is from Hale Co., Alabama, which is ca. 532 km away. A voucher specimen is on deposit at the Louisiana State University Herbarium (LSU) in Baton Rouge.

Voucher. **Louisiana**. Natchitoches Par.: Calcareous woodland surrounding hilltop prairie ca. 3.5 km SSE of Provencal, 9 Jun 2016, *Doffitt 3431* (LSU).

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TWO NEW SPECIES OF *MACRODIPLOPHYLLUM* (SCAPANIACEAE, MARCHANTIOPHYTA) ENDEMIC TO WESTERN NORTH AMERICA

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ABSTRACT

Macrodiplophyllum rubrum D.H. Wagner, **sp. nov.**, and **Macrodiplophyllum flaccidum** D.H. Wagner, **sp. nov.**, are described from the northwest coast of North America. Previously confused with *Macrodiplophyllum plicatum* (Lindb.) Perss., they are separated by an array of distinctive morphological characters. Whereas *M. plicatum* is distributed in an arc around the North Pacific from British Columbia to Japan, *M. rubrum* is presently known only from California to northern British Columbia and *M. flaccidum* has been found from northern Oregon to southeastern Alaska.

In the course of preparing a treatment of *Macrodiplophyllum* for the liverwort volume of Flora of North America, the author detected two undescribed species in the herbarium of the University of British Columbia from among the three hundred and forty specimens filed under *M. plicatum* (Lindb.) Perss. The author had anticipated the presence of the first of these based on plants from southwest Oregon first found in 1997 and included in his identification guide to the liverworts of Oregon (Wagner 2014). These Oregon plants were initially identified as *M. plicatum* based on the keys in Godfrey (1977) and Hong (1980) but did not match the description found in Choi et al. (2012). Davison (1993) mentioned a discussion with Schofield about a distinctive form of *M. plicatum* in northern British Columbia and Alaska that deserved further study; this form proved to be the second species described here.

MACRODIPLOPHYLLUM RUBRUM D.H. Wagner, **sp. nov.** (Figures 1-5).

Plantae 20–70 x 2–4 mm, ex lutescenti-viridi pallide olivaceo-virides; rami laterales, plerumque uti innovationes geminati gynoecia infecundata subtendentes; folia complicato-biloba, patentia, in parte distali pectinata, non imbricata, longitudine lobi dorsalis 0.45–0.7 longitudinis lobi ventralis. Lobus dorsalis non decurrens, sub angulo 42-54º ex axe caulis abiens, oblongus vel ligulatus, convexiusculus, apice rutundatus, base arcte caulem involvens et eum transiens, ad punctum carinae oppositum attingens. Lobus ventralis transverse insertus, linea insertionis valde arcuata, ad dimidium latitudinis caulis decurrent, ligulatus, apice rotundatus, valde convexus, saepe siccitate deflexus, margine basali limbo bene definito e cellulis pachyticho latitudine 2-5 cellularum, usque 1 mm supra insertionem attingens, dentibus gracilibus unicellularibus interdum recurvis spinosis arcte armata, limbo spinoso plerumque valde apice surculi rubro-tincto, aetate obscurante, cuticula verruculosa, carina subrecta, et ad marginem lobi anticam parallela, 0.45-0.7 partem longitudinis lobi. Corpora oleosa per cellulam 5-8 (-10), sphaerica vel elliptica, granulosa. Gemmae frequentes, ex sphaerico rotundae, polygonicae, 2(–4)-cellulares, pallide brunneolae. Dioica, androecia ignota; gynoecia terminalia, interdum perianthiis praesentibus, ore lobulato-ciliato, lobulis ramosis, gracilibus, apice argutis, longitudine ex 6–10(–20) cellulis composita.

TYPE: USA. Oregon. Coos Co.: Cherry Creek Research Natural Area, ca. 20 mi SE of Coos Bay, streamside terrace, on *Thuja plicata* trunk, 43º 13′ 10″ N, 123º 56′ 5″ W, elev. 640 ft (195 m), 13 Jun 2016, *D.H. Wagner m3014* (holotype: OSC; isotypes: CAS, E, F, H, MO, NY, UBC, VBGI, WTU).

Plants 20–110 x 2–4 mm, ascending to erect, in tufts or scattered among other bryophytes, yellowish green to pale olive green; stems 440–520 x 320–350 µm, one layer of outer cortical cells thick walled, olive green at apex, dark brown to black below, branches lateral, frequently producing paired innovations subtending unfertilized gynoecia; leaves squarrose, imbricate-sheathing at base, spreading, distally pectinate, not imbricate; dorsal to ventral lobe length ratio 0.45–0.7, keel nearly straight and parallel to antical lobe margin, 0.5–0.75 of lobe length; dorsal lobe subtransversely inserted, insertion line weakly arched, not decurrent, angled 42–54° from stem axis, oblong to narrowly rectangular, slightly convex, apex rounded, usually dentate or eroded by gemma formation, lobe base reaching across stem and tightly wrapped around opposite side, 1.1–1.5 x 0.6–0.7 mm; ventral lobe transversely inserted, insertion strongly line arched, decurrent to half the stem width, midline angled 55–85° from stem axis, narrowly rectangular, apex rounded, strongly convex, often deflexed when dry, 2.0–2.6 x 0.8–1.2 mm, apex dentate or eroded by gemma formation, basal margin with a well defined strip of 2—5 rows of thick-walled cells extending up to 1 mm from point of insertion, armed with closely set, slender, unicellular, sometimes recurved spinose teeth, the spinose strip usually strongly red pigmented; cells at leaf base elongate-rectangular, 75–95 x 17–20 µm, trigones bulging, cell walls nodose thickened; median cells (18–)20–23(–27) µm, trigones concave to moderately bulging, 2—3 rows of marginal cells evenly thick walled; cuticle striolate to verrucose; oil bodies 5–8(–10) per cell, spherical to elliptical, granulose; specialized asexual reproduction produced in masses at apices of leaves, frequent, spherical or elliptical to rounded polygonal, 2(–4) celled, pale green to light tan.

Sexual condition dioicous; androecia not known; gynoecia terminal, occasional, female bracts in one pair, distinctly larger than sterile leaves, dorsal lobe to 1.7 mm, ventral lobe to 2.9 mm; small bractlets sometimes included; perianth deeply plicate to base, long emergent, mouth lobulate-ciliate, lobulae branched, slender, sharp tipped, 6–10(–20) cells long, 1–4 cells wide; sporophytes not known.

Etymology. The specific epithet refers to the prominent, spinose-toothed, reddish orange basal margin of the ventral lobes.

Ecology and distribution. Entirely restricted to organic substrates, commonly on bark of trees near their base or on decaying logs, occasionally on peaty humus, confined to coniferous forests near the coast of Alaska, British Columbia, Washington, Oregon, and California. The frequent occurrence on tree bases in the immediate coastal zone is in striking contrast to the other species of the genus, which are primarily terrestrial on cliffs, boulders or sandy soil. Although *M. rubrum* occurs with frequency on hummocks in wetlands in the northern parts of its range, these are distinctly organic substrates.

Additional specimens examined. See Appendix 1.

Figure 1. *Macrodiplophyllum rubrum*. A. Plants *in situ* on *Pseudotsuga* log. B. Hand specimen. Photos by D.H. Wagner.

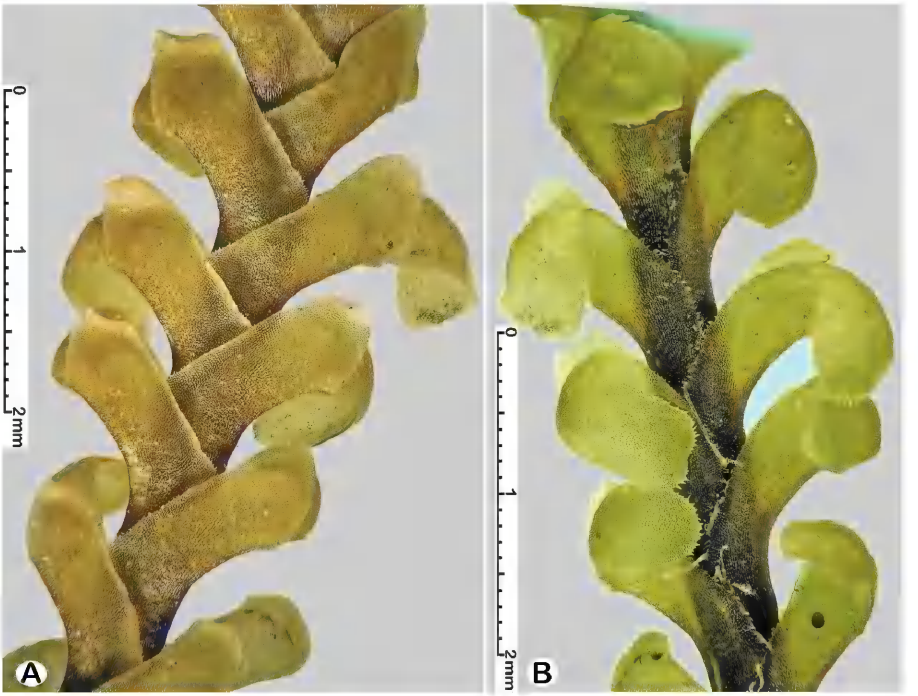

Figure 2. *Macrodiplophyllum rubrum.* A. Dorsal aspect. B. Ventral aspect. A&B. *Schofield 86525* (UBC)

These images (Fig. 2) were made with a Nikon Coolpix E8800 mounted on a Nikon Eclipse E200 microscope. Reflected light was provided by two Expilion Cygolite bicycle headlamps. Stacked images were processed with Helicon Focus.

The nearly parallel keel and dorsal lobe margin are clearly demonstrated in Figure 2A. This is easily recognized in herbarium specimens with a dissecting microscope examination. Fresh specimens have their ventral lobes spreading nearly horizontally, not tightly curled around the lower side of the stem as in herbarium specimens.

This photographed specimen is dry; the colors are not typical of fresh specimens. In Figure 2B note the spinose teeth along the basal margin of the ventral lobes. These are strongly red pigmented in almost all collections seen but even when unpigmented the character is clearly recognizable, distinctive and diagnostic.

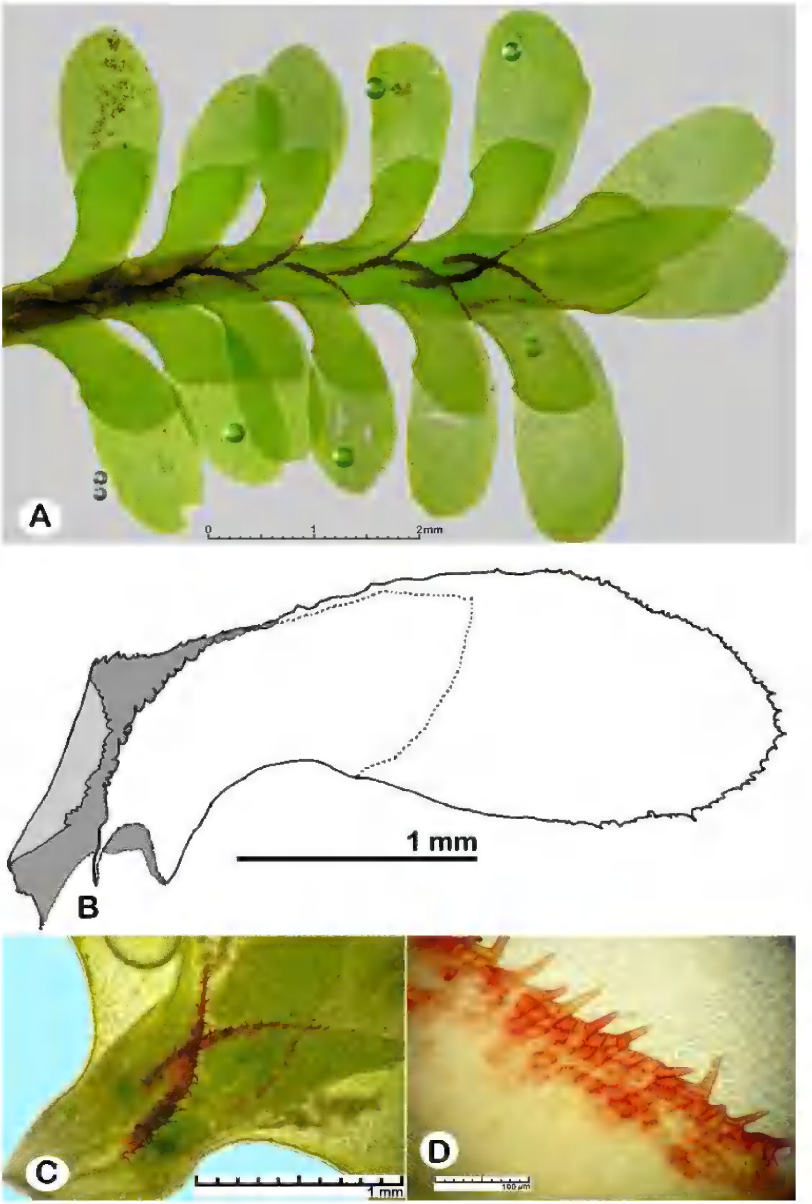

Figure 3. *Macrodiplophyllum rubrum.* A. Whole shoot, ventral aspect. B. Leaf, ventral aspect. C. Ventral lobe base detail. D. Spinose teeth on ventral lobe base. A,C,D from *D.H. Wagner m3006* (OSC). B from *L.Russell s.n.* (OSC).

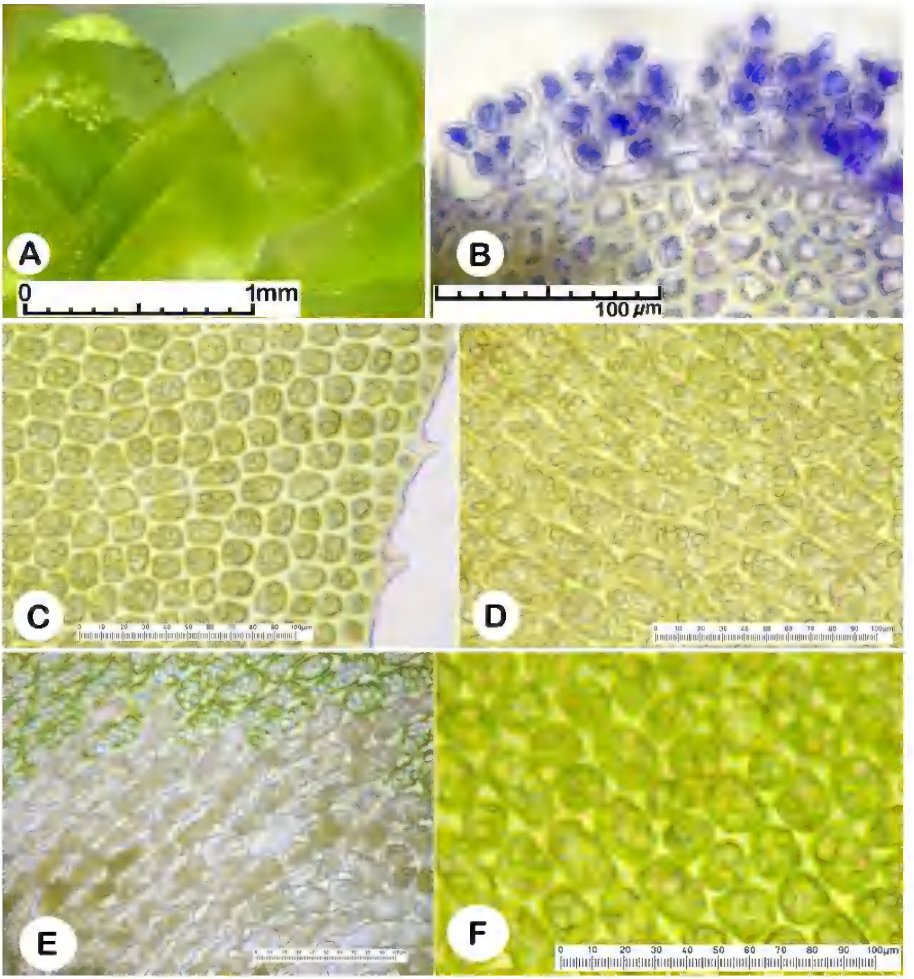

Figure 4. *Macrodiplophyllum rubrum.* A. Fresh shoot apex with gemmae on leaf margins. B. Stained gemmae along leaf margin. C. Marginal to interior leaf cells of fresh specimen, with oil bodies clearly visible. D. Proximal cells near base of ventral lobe, showing oil bodies. E. Basal leaf cells, with cell wall thickenings in dead cells clearly shown. F. Median leaf cells, focus on leaf surface to show verrucose-papillose surface. A, F: *Wagner m3014* (Holotype, OSC). B: *Wagner 9051* (OSC). C, D, E: *Wagner m3006* (OSC).

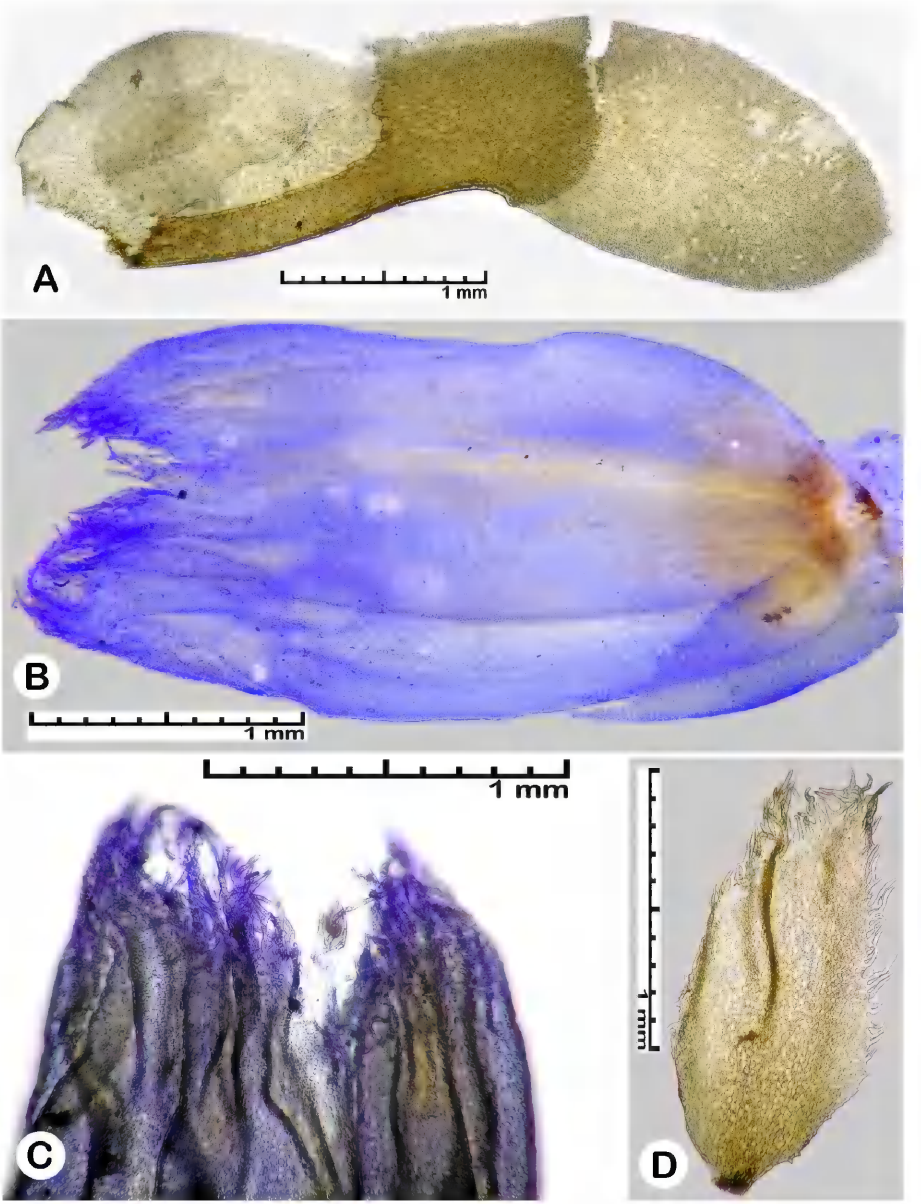

Figure 5. *Macrodiplophyllum rubrum.* A. Female bract, ventral aspect; ventral lobe base removed to reveal bractlet. B. Perianth, stained. C. Branched lobulae at perianth moutn. D. Bractlet. A--D *Wagner m1120* (OSC).

MACRODIPLOPHYLLUM FLACCIDUM D.H. Wagner, **sp. nov.** (Figures 6-9).

Plantae 20–60 x 2–4 mm, ex lutescenti-viridi pallide olivaceo-virides, interdum prope apicem rubro-tinctae; caules sparsim ramosi; folia complicato-biloba, contigua vel pro parte maxima imbricata, longitudine lobi dorsalis 0.45–0.7 longitudinis lobi ventralis, lobo dorsali vel ventrali longitudine proportione latitudinis 0.5–0.7. Lobus dorsalis leniter decurrens usque portionem 0.1-0.2 latitudinis caulis, linea media a base usque apicem aequicurva, sub angulo 30-80° ex axe caulis abiens, oblique obovatus vel arcuatus, planus vel subconvexus, apice obtusus vel rotundus, margine basali paene caulem transiente ad latus oppositum attingente. Lobus ventralis usque portionem 0.1-0.2 latitudinis caulis decurrens, oblique obovatus vel spathulatus, leniter falcatus, subconvexus, siccitate contortus, ad marginem subtiliter dentatus, ad basem lobi dentibus paucis praeditus, dentibus uniformiter effectis in triente distali nisi in parte erosa per propagationem gemmarum, apice lobi ventralis interdum dentibus multicellularibus praedito, cellulis trigonis maximam partem valde tumidis, cuticula praeprimis laevi, carina a base aequicurvante, saepe atrofusca vel atra, 0.3-0.5 lobi ventralis attingente. Corpora oleosa per cellulam 2-3(-4), reniformi-fusiformia, textura amorphica, pallide brunnea, paene lumen cellulare implente Dioica, androecia frequentia, bracteis uti foliis vegetativis sed ad basem gibberis; gynoecia frequentia, terminalia, perianthiis frequentibus, ore lacerato lobulis gracilibus sparsim ramosis usque longitudinem 8 cellularum. Sporophyta ignota..

TYPE: CANADA. British Columbia. Haida Gwaii (Queen Charlotte Islands): Graham Island, along Rennell Sound Forest Service Road, between Rennell Sound and the Queen Charlotte Main Line Junction, W of Phantom Creek, 53° 21′ 21″ N, 132° 19″ 17″ W, elev. 244-247 m, 15 Jul 2010, *S. Joya* and *J. & W. Harpel 945* (holotype: UBC; isotypes: CAS, E, F, H, MO, NY, OSC, VBGI).

Plants 20–60 x 2–4 mm, ascending to erect, yellowish green to pale olive green, sometimes tinged red near apex, glossy when dry, stems 335–370 x 235–260 µm, outer cortical cells thick walled in 2–4 layers, olive green at apex, dark brown to black below, sparsely branched, leaves contiguous to imbricate, contorted when dry; dorsal to ventral lobe length ratio 0.5–0.7; dorsal lobe subtransversely inserted, insertion line weakly arched, weakly decurrent for 0.1–0.2 of stem width, midline smoothly curved from base to apex, angled 30–80° from stem axis, obliquely obovate to arcuate, flat to slightly convex, apex obtuse to rounded, basal margin reaching across stem not quite to opposite side, 1.2–1.6 x 0.5–0.8 mm; ventral lobe transversely inserted, insertion line slightly arched, decurrent for 0.1–0.2 of stem width, midline angled 60–90° from stem axis, obliquely obovate to spatulate, weakly falcate, slightly convex; 1.4–1.9 x 0.4–0.9 mm; keel curving evenly from base, often dark brown to black, 0.3–0.5 of ventral lobe; margins finely dentate with few teeth at lobe bases but teeth regularly produced on distal third except where eroded by gemma production, apex of ventral lobe with occasional multicellular teeth; cells at leaf base elongate-rectangular, 36–40 x 18-20 µm, trigones strongly bulging, walls nodose; median cells isodiametric to short rectangular, (15–)20–26(–27) µm, trigones bulging, evenly thick walled cells in 2–3 cell rows at margin; cuticle smooth; oil bodies 2–3(–4) per cell, reniform-fusiform, amorphous texture, pale brown, nearly filling cell lumen, specialized asexual reproduction not known.

Sexual condition dioicous; androecia frequent, like vegetative leaves but strongly gibbous at base, with 3-5 antheridia in each bract; gynoecia terminal, frequent, female bracts similar to but larger than sterile leaves; perianth deeply plicate in distal half, long emergent, mouth lacerate with slender, sparsely branched lobulae up to 8 cells long; sporophytes not known.

Etymology. The specific epithet refers to the appearance of herbarium specimens, the dead leaves appearing limp and flaccid like dried lettuce.

Ecology and distribution. This species grows exclusively on inorganic substrates, typically on cliffs and streamside rocks at low elevations, often associated with waterfalls, occasionally on

mineral soil around rocks. It is known from British Columbia, Washington, Oregon and California. It is notably absent from tree trunks or fallen logs.

Additional specimens examined. See Appendix 2.

Figure 6. *Macrodiplophyllum flaccidum.* A. Dry shoot, dorsal aspect. B. Dry shoot, ventral aspect. Both images at same magnification. A & B: *Schofield 84237* (UBC).

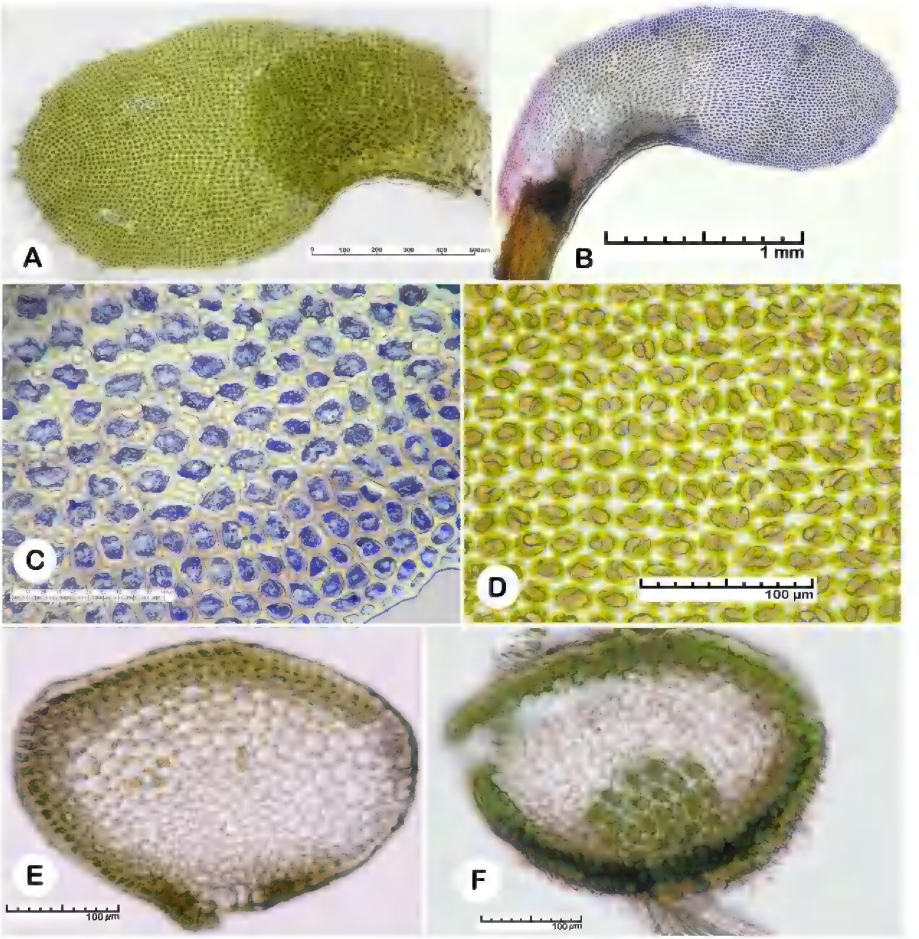

Figure 7. *Macrodiplophyllum flaccidum.* A. Fresh leaf, dorsal aspect. B. Stained leaf, ventral aspect. C. Marginal basal cells, stained, female bract. D. Median cells with oil bodies. E. Stem section. F. Stem section. A, D, E, F: *Wagner m2795* (OSC). B, C: *Schofield 67624* (UBC).

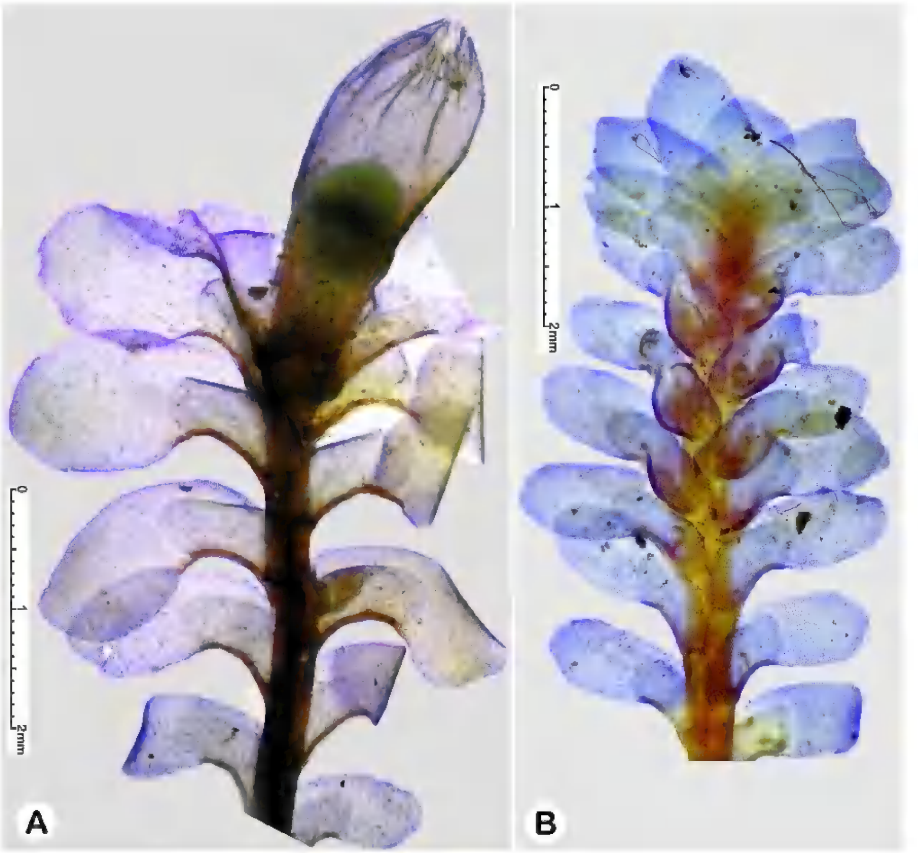

Figure 8. *Macrodiplophyllum flaccidum.* A. Female shoot with perianth, dorsal aspect, stained, distal two thirds of female bracts removed to expose perianth base. B. Male shoot, dorsal aspect, with antheridia visible in male bracts, stained. Both images at same magnification. A & B: *Schofield 21535* (UBC).

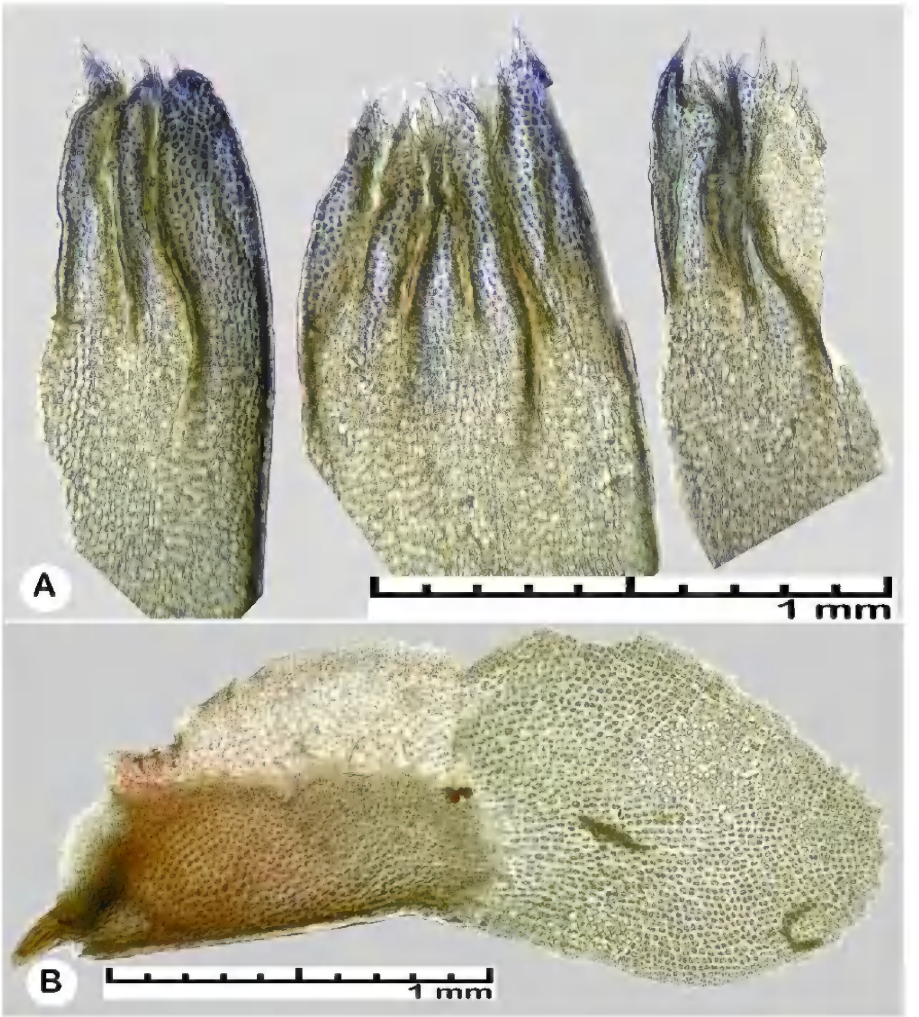

Figure 9. *Macrodiplophyllum flaccidum.* A. Dissected perianth, lightly stained. B. Female bract. A & B: *Schofield 67624* (UBC).

Key to species of *Macrodiplophyllum*

1. Dorsal lobe base reaching across stem and tightly curled around stem opposite the keel; ventral lobe base with a well defined strip of thick-walled marginal cells armed with slender, unicellular, spinose teeth; spinose strip often strongly red pigmented; on either organic or inorganic substrates.

    2. Cuticle striolate to verrucose; leaves contiguous, evenly spaced so the keel is usually exposed at stem to leaf junction; midline of distal half of ventral lobes diverging 42—54° from stem; spinose strip at base of ventral lobe usually bright red; invariably on bark, wood or humus ..... **Macrodiplophyllum rubrum** D.H. Wagner
    2. Cuticle strongly papillose with several globose papillae over each median cell; leaves closely imbricate with few keels exposed; midline of distal half of ventral lobes diverging around 90° from stem; spinose strip at base of ventral lobes not pigmented; on rock or arctic peaty soil ..... **Macrodiplophyllum microdontum** (Mitt.) Perss.

1. Dorsal lobe base reaching 0.5 to 0.9 across stem but not wrapped around opposite side; ventral lobe base entire or with scattered marginal teeth, low or up to 4 cells long, not spinose; margins unpigmented or at most light pink; mostly on inorganic substrates but including peaty arctic soil.

    3. Dorsal lobes 0.7—0.9 as long as ventral lobes; margins uniformly entire ..... **Macrodiplophyllum imbricatum** (M.A. Howe) Perss.
    3. Dorsal lobes less than 0.7 as long as ventral lobes; margins sparsely to moderately dentate, at least at apex of lobes.

        4. Distal half of ventral lobe angled less than 75° from stem; lobes with few teeth; leaf shape changed little upon drying ..... **Macrodiplophyllum plicatum** (Lindb.) Perss.
        4. Distal half of ventral lobe angled close to 90° from stem; both lobes usually dentate, teeth usually prominent at lobe apices; leaf shape collapsing upon drying ..... **Macrodiplophyllum flaccidum** D.H. Wagner

Discussion

Macrodiplophyllum is distinguished by its robust character, rounded, long lingulate leaf lobes, elongated basal cells, arcuate and decurrent ventral lobe, and plicate perianth, usually to the base, with a constricted mouth. It is a natural group characterized by an array of ancestral traits rather than strict phylogenetic lineage. Phylogenetic analysis shows that *Macrodiplophyllum* is derived from the more generalized genus *Diplophyllum* and is basal to two more specialized genera, *Douinia* and *Scapania*. Alternate classifications would place the known species of *Macrodiplophyllum* in *Diplophyllum* (Hong 1980; Steere 1978), all in *Scapania* (Potemkin 2002), or divide its species between *Scapania* and an enlarged *Douinia* (Konstantinova et al. 2013). Until the two new species are subjected to molecular analysis their position in phylogenetic trees cannot be used to evaluate alternate classifications in Scapaniaceae.

The similarity of these two new species to *Macrodiplophyllum plicatum* is reflected in the UBC herbarium, where none of the approximately 100 specimens of each were identified as either of the other two species of the genus, *M. imbricatum* (M.A. Howe) Perss. or *M. microdontum* (Mitt.) Perss. Their evolutionary closeness may not be reflected in molecular phylogeny of this group (Heinrichs et al. 2012).

Macrodiplophyllum flaccidum is the most similar of the two to *M. plicatum* in morphology and ecology. Both occur almost exclusively on inorganic substrates such as cliff faces, boulders, and sandy soil. One of the most distinctive character of *M. flaccidum*, dry and contorted leaves, is seen only in dried specimens. Therefore, it is more easily recognizable in the herbarium than in the field. The presence of a black keel and black stem is suggestive but not diagnostic. Whereas most species of this genus have at least some roughening of the cuticle, described as striolate or verruculose, the

cuticle of *M. flaccidum* is usually nearly quite smooth so the plants appear glossy or shiny when dry. Dry specimens of *M. plicatum* have a distinctly velvety or satiny appearance. Perianths with plications in the distal half only, as in *M. flaccidum*, are anomalous in *Macrodiplophyllum*, the other species having perianths plicate to the base.

Although superficially quite different in general appearance, *Macrodiplophyllum rubrum* shares some of its most distinctive characters with *M. microdontum*. *Macrodiplophyllum microdontum* is the taxonomically most remote member of traditional *Macrodiplophyllum*. Phylogenetic cladograms suggest it is closer to *Scapania* than the rest of *Macrodiplophyllum* (Heinrichs et al. 2012). The significance of their evolutionary closeness when additional molecular phylogeny is obtained might suggest optimal generic delimitation in the future. The most prominent diagnostic characteristic of this species, the bright red, spinose margin of the ventral lobes, is quite easily detected in the field with a hand lens.

The extensive lists of specimens examined demonstrate that these two new species are not likely to be of immediate conservation concern except at the margins of their range. Within their relatively narrow distribution, they are both of frequent occurrence. The cluster of populations of *Macrodiplophyllum rubrum* in Coos County, Oregon is striking. It may be a consequence of the local botanists being tuned to a search image but records elsewhere in Oregon and to the north in Washington State indicate limited abundance in most of Oregon coastal forests. The record of *M. rubrum* from California is supported by communications with William Doyle regarding a collection he made in Humboldt County (Doyle & Stotler 2006) originally named *Diplophyllum plicatum*.

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Appendix 1. Additional specimens examined, *Macrodiplophyllum rubrum*

CANADA. British Columbia.

North Coastal Islands. Pitt Island, Newcombe Harbor, base of *Chamaecyparis* tree, 53° 43′ N, 130° 06′ W, *Schofield 86967,* 12 Aug 1986 (UBC); Pitt Island, Holmes Lake, S shore, base of tree on bog slope, 53° 35′ N, 130° 00′ W, 21-23 Jun 1979 *Schofield, Vitt,* & *Horton 72498* (UBC); Larsen Island N of Banks Island, Larsen Harbour, Hecate Strait, shaded outcrop face, 53° 35′ N, 130° 35′ W, 4 Jun 1970, *Schofield 41803* (UBC); Pitt Island, Monckton Inlet, streamlet on N side of inlet, slope in open *Chamaecyparis* forest, 53° 19′ N, 129° 40′ W, 10 Aug 1986, *Schofield 86758* (UBC); Moore Islands, Hecate Strait, shaded cliff in forest, 52° 40′ N, 129° 25′ W, 1 Jun 1970, *Schofield 41552* (UBC); Powell Anchorage, Tuno Creek mouth, S. Don Peninsula, up base of *Chamaecyparis*, 52° 17′ N, 128° 19′ W, 7 Aug 1986, *Schofield 8639* (UBC); King Island, Codville Lagoon, Sager Lake, bank in open forest, 52° 03′ N, 127° 49′ W, 4 Aug 1986, *Schofield 86243* (UBC); King Island, near Codville Lagoon, slopes of Codville Hill, cliff in forest, 52° 03′ N, 127° 52′ W, 12 Apr 1970, *Schofield 40884* (UBC); Lagoon Lake continuous with Fish Egg Inlet, on cliff in forest, 51° 40′ N, 127° 46′ W, 13 Apr 1970, *Schofield 41056* (UBC); Keith Anchorage area, Kwakshua Channel, NW Calvert Island, base of tree in forest, 51° 40′ N, 128° 08′ W, 18-20 Jun 1965, *Schofield & Williams 27039* (UBC); Robinson Island, Brandon Point, mouth of Blunden Harbour, shaded bank in forest, 50° 54′ N, 127° 17′ W, 14 Apr 1970, *Schofield 41153* (UBC); Inlet on E side of Nigei Island, just NW of Browning Passage, N end, on shaded bank near lake, 50° 52′ N, 127° 40′ W, 10 Apr 1970, *Schofield 40749* (UBC); Fraser Island, Port Alexander, SE side of Nigei Island, damp cliff crevice, 50° 51′ N, 127° 38′ W, 10 Apr 1970, *Schofield 40703* (UBC).

Haida Gwaii (Queen Charlotte Islands). Graham Island, Cape Fife Trail from Tow Hill toward E coast, hummock in forest, 54° 05′ N, 131° 45′ W, *Schofield, Ellis & Schofield 119760,* 20 Jun 2002 (UBC). Graham Island, Cape Fife Trail, humus bank in forest, 54° 05′ N, 131° 45′ W, *Schofield, Ellis & Schofield 120042,* 26 Jun 2002 (UBC). Graham Island, Tow Hill, 54° 05′ N, 131° 51′ W, *Varaama 64162Q-01,* 7 Jun 1964 (UBC). Graham Island, near Tow Hill, bog, 54° 04′ N, 131° 48′ W, *Schofield & Krajina 39392,* 22 Jul 1969 (UBC). Graham Island, Trail to E coast from Tow Hill, on humus banks in forest, 54° 03′ N, 131° 55′ W, *Schofield 29908,* 22 Jun 1966 (UBC). Tow Hill, Graham Island, on boulder of forest slope, 54° 03′ N, 131° 55′ W, *Schofield & Vaarama 23745,* 7 Jun 1964 (UBC). Graham Island, just N of Port Clements, log in forest, 53° 40′ N, 132° 10′ W, *Schofield & Beil 55940,* 22 Jun 1974 (UBC). Graham Island, Masset Inlet, head of Dinan Bay, up tree base in forest, 53° 38′ N, 132° 40′ W, *Schofield, Ellis & Schofield 119813,* 21 Jun 2002 (UBC). Graham Island, Blackwater Creek, near junction with Mamin River, S of Juskatla, humus at base of tree in forest, 53° 37′ N, 132° 20′ W, *Schofield & Vaarama 24551,* 14 Jun 1964 (UBC). NE Graham Island, Massett Sound, near road, 2 mi S. of Massett, on banks and up tree bases in swampy spruce forest, 53° 55′ N, 132° 08′ W, *Schofield 34794,* 27 Jul 1967 (UBC). N Graham Island, Eden Lake, central E side, on base of cedar, 53° 50′ N, 132° 45′ W, *Schofield 35194,* 30 Jul 1967 (UBC). W

Graham Island, Virgalias Cove, Port Louis, shaded cliff, 53º 42′ N, 132º 58′ W, *Schofield 34128,* 25 Jun 1967 (UBC). Graham Island, McClinton Bay, SW Massett Inlet, epiphytic on apple tree, 53º 40′ N, 132º 40′ W, *Schofield 35260,* 30 Jul 1967 (UBC). Graham Island, V.J.K. Ecological Reserve, Athlow Bay, Port Chanal, Empire Ancorage-Goose Cove, 53º 35′ N, 132º 55′ W, *Godfrey & Godfrey 3996,* 7 Jun 1977 (UBC). W Graham Island, Goose Cove, Athlow Bay, on hummocks near tree base in forest, 53º 35′ N, 132º 55′ W, *Schofield 30588,* 2 Jul 1966 (UBC). W Graham Island, Goose Cove, Athlow Bay, near anchorage, shaded cliff shelf in canyon, 53º 35′ N, 132º 55′ W, *Schofield 37192,* 29 Jul 1968 (UBC). W Graham Island, Goose Cove, Athlow Bay, stump on forest slope, 53º 35′ N, 132º 55′ W, *Schofield 64613,* 610 Jun 1977 (UBC). Graham Island, 4 mi S of Tlell, on hummocks in swampy forest, 53º 30′ N, 131º 55′ W, *Schofield 29787,* 20 Jun 1966 (UBC). Graham Island, near Brent Creek, *Chamaecyparis* bog, 53º 20′ N, 132º 15′ W, *Schofield 30110,* 26 Jun 1966 (UBC). Graham Island, ca 5 mi N of Honna River mouth, on bank in forest, 53º 18′ N, 132º 15′ W, *Schofield 30151,* 26 Jun 1966 (UBC). SW Graham Island, Van Inlet, between head of inlet and lake, at base of spruce in floodplain, 53º 17′ N, 132º 29′ W, *Schofield & Sjors 32092,* 22 Jul 1966 (UBC). Moresby Island, sandspit area, near mouth of Hanns Creek, on log in forest, 53º 15′ N, 131º 50′ W, *Schofield & Krajina 39625,* 24 Jul 1969 (UBC). Graham Island, Queen Charlotte City, close to the sea,, 53º 15′ N, 132º 04′ W, *Persson s.n.,* 1 Jul 1957 (UBC). Moresby Island, sandspit, on *Picea sitchensis*, 53º 14′ N, 131º 49′ W, *Krajina s.n.,* 25 Jul 1968 (UBC). Moresby Island, near Centre Bay, Skidgate Channel, open hummock in forest, 53º 12′ N, 132º 30′ W, *Schofield 30751,* 4 Jul 1966 (UBC). Moresby Island, Skidegate Channel, S side of West narrows, humus hummock in forest, 53º 10′ N, 132º 25′ W, *Schofield 30699,* 3 Jul 1966 (UBC). Moresby Island, canyon near S bay, Skidegate Channel, bases of trees, 53º 09′ N, 132º 05′ W, *Schofield & Sharp 25917,* 12 Sep 1964 (UBC). Moresby Island, brooklet near entrance to E narrows, Skidegate Channel, on rotten logs, 53º 09′ N, 132º 32′ W, *Schofield 14012,* 17 May 1961 (UBC). Moresby Island, Deena River, dampish bank in woodland, 53º 08′ N, 132º 08′ W, *Schofield 15789,* 28 Aug 1961 (UBC, WTU). Moresby Island, Deena River, ca 8 mi from mouth, on alder in floodplain, 53º 08′ N, 132º 08′ W, *Schofield 30779a,* 4 Jul 1966 (UBC). Chaatl Island, frequent under trees in forest, 53º 07′ N, 132º 30′ W, *Schofield & Boas 18697,* 9-12 Jul 1962 (UBC). Chaatl Island, up tree base, 53º 07′ N, 132º 30′ W, *Schofield & Boas 18909,* 9-12 Jul 1962 (UBC). NW Moresby Island, Mackenzie Cove, bank in woods, 53º 05′ N, 132º 20′ W, *Schofield 31136,* 9 Jul 1966 (UBC). Graham Island, Long Inlet, Lagins Creek, common on banks in floodplain forests, 53º 00′ N, 132º 00′ W, *Schofield 29979,* 24 Jun 1966 (UBC). Moresby Island, S entrance of Louise Narrows, up base of Sitka spruce in forest, 52º 57′ N, 131º 54′ W, *Schofield 45335,* 7 Jul 1971 (UBC). Moresby Island NW, N slope of 'Laing Point' Mountain, NE side of Peel Inlet, on hummocks in forest, 52º 59′ N, 132º 05′ W, *Schofield 30267,* 28 Jun 1966 (UBC). NW Moresby Island, Peel Inlet, on log, 52º 59′ N, 132º 06′ W, *Schofield 15414,* 23 Aug 1961 (UBC). Louise Island, Mathers Lake, S end, base of *Pyrus* tree of lake shore, 52º 58′ N, 131º 50′ W, *Schofield 37332,* 31 Jul 1968 (UBC). Princess Royal Island, Chapele Inlet, stream canyon near mouth, E side, slope in open forest, 52º 55′ N, 129º 08′ W, *Schofield 86596,* 9 Aug 1986 (UBC). Moresby Island, stream to lake on NE side of Newcombe Inlet, Tasu Sound, on bank by stream, 52º 50′ N, 132º 05′ W, *Schofield 37359,* 1 Aug 1968 (UBC). Moresby Island, Tasu Creek mouth, head of Newcombe Inlet, Tasu Sound, damp earth near stream, 52º 50′ N, 132º 08′ W, *Schofield 37616,* 4 Aug 1986 (UBC). Moresby Island, Kootenay Inlet, N side, near head, on humus at tree base, 52º 50′ N, 132º 11′ W, *Schofield & Krajina 39524,* 24 Jul 1969 (UBC). Moresby Island, Kootenay Inlet, S side near head of inlet, mouth of waterfall filled creek, 52º 50′ N, 132º 11′ W, *Schofield & Krajina 39587,* 23 Jul 1969 (UBC). Richardson Island, SE end, E coast of Moresby Island, humus of bank above sea cliff, 52º 44′ N, 131º 44′ W, *Schofield & Vaarama 24191,* 11 Jun 1964 (UBC). Moresby Island SE, Crescent Inlet, humus near tree base, 52º 44′ N, 131º 48′ W, *Schofield & Vaarama 24401,* 12 Jun 1964 (UBC). E Moresby Island, Bigsby Inlet, small harbor just S, base of cliff, 52º 37′ N, 131º 43′ W, *Schofield 32521,* 28 Jul 1966 (UBC). Moresby Island, Barry Inlet, S side, near mouth, 52º 35′ N, 131º 50′ W, *Schofield, Spence, Lemmon & Brown 84452,* 21 Aug 1985 (UBC). Burnaby Island, Section Cove, up base of Sitka spruce trunk, 52º 25′ N, 131º 21′

W, *Schofield 44720,* 2 Jul 1971 (UBC). Kunghit Island, Monserrat Bay, S of Rainy Island, cliff face, 52° 05′ N, 131° 03′ W, *Schofield 44775,* 2 Jul 1971 (UBC).

South East Mainland. Haney Research Forest, near banks of Alouette River, overturned tree root in forest, 49° 13′ N, 122° 36′ W, *Schofield, Godfrey, Godfrey & Nuszdorfer 68319,* 6 Apr 1978 (UBC).

Vancouver Island. Brooks Peninsula, on W side of lagoon near base camp, bogs, 50° 10′ N, 127° 45′ W, *Schofield 76997,* 19 Aug 1981 (UBC). Brooks Peninsula, on W side of lagoon near base camp, bogs, 50° 10′ N, 127° 45′ W, *Schofield 77007,* 19 Aug 1981 (UBC). Brooks Peninsula, toward base of 'Mt. Doom', bog slopes, 50° 10′ N, 127° 45′ W, *Schofield 77178,* 22 Aug 1981 (UBC). Tahsish Inlet, shaded forest cliff, humus on rock, 50° 08′ N, 127° 05′ W, *Halbert, Price & Doak 7207,* 6 Jun 1971 (UBC). Brooks Peninsula, barren gravel ridge above Cape Cook, base of tree trunk, 50° 07′ N, 127° 54′ W, *Schofield 68515,* 7 Jun 1978 (UBC). Ucluelet-Tofino Hwy, ca 19 mi E of junction, river margin, 49° 11′ N, 125° 23′ W, *Schofield 38878,* 7 May 1969 (UBC). Lost Shoe Creek nearby, Tofino Area, on cedar trunk in boggy forest, 49° 00′ N, 125° 38′ W, *Schofield 26497,* 2 May 1965 (UBC). Zeballos Inlet, Barr Creek N of Hecate Channel, trunk of *Malus diversiloba*, 49° 55′ N, 126° 47′ W, *R.L. Halbert, Price & Doak 7380,* 9 Jun 1971 (UBC). Zeballos Inlet, Barr Creek N of Hecate Channel, damp shaded cliff, on rock, 49° 55′ N, 126° 47′ W, *Halbert, Price & Doak 7442,* 9 Jun 1971 (UBC). Nootka Sound, near mouth of Tahsis Inlet, N of Strange Island, base of tree in forest, 49° 44′ N, 126° 37′ W, *Schofield & Halbert 40243,* 1 Oct 1969 (UBC). Nootka Island, Crawfish Lake, just W of lake, Moist mature Hemlock forest, 49° 41′ N, 126° 50′ W, *Halbert, Price & Doak 4824,* 12 Jun 1970 (UBC). Nootka Sound, Muchalat Inlet, S side King Passage, opposite Gore Island, damp slope near waterfall, 49° 38′ N, 126° 23′ W, *Schofield 40303,* 2 Oct 1969 (UBC). Bligh Island, Clerke Peninsula, Resolution Cove, S side, Nootka Sound, base of tree in forest, 49° 36′ N, 126° 32′ W, *Schofield & Halbert 40345,* 2 Oct 1969 (UBC). Tofino Inlet area, coastal *Thuja* forest, level, windthrow, humic gleysol, 49° 06′ N, 125° 41′ W, *D. Gagnon, F.M. Palmer 80-50-6,* 6 Aug 1980 (UBC). Trail from Rubas Hill down to beach, in dense Hemlock-Cedar-Spruce forest, on decaying wood, 49° 05′ N, 125° 05′ W, *Otto 1781,* 20 Jun 1967 (UBC). Effingham Inlet, just NE of Webster Island, shaded vertical cliff face, 49° 05′ N, 125° 09′ W, *Halbert, Price & Doak 7024,* 30 Oct 1970 (UBC). Effingham Inlet, just NE of Webster Island, shaded humus face, 49° 05′ N, 125° 09′ W, *Schofield 43470,* 30 Oct 1970 (UBC). Tofino Road, ca. 12 mi N of Ucluelet, on bark of tree, 49° 05′ N, 125° 48′ W, *Schofield 13466,* 23 Apr 1961 (UBC). Kennedy Lake, near E end of lake, bog near road, on tree trunk, 49° 04′ N, 125° 34′ W, *Schofield 43747,* 20 Mar 1971 (UBC). Tofino, ca. 10 km S, cedar trunks in forest, 49° 04′ N, 125° 46′ W, *Schofield &. Schofield 77756,* 17 Jun 1982 (UBC). Long Beach area, near Wickannish Inn, 49° 03′ N, 125° 40′ W, *Wade s.n.,* Jun 1964 (UBC). Pacific Rim National Park, behind Long Beach, Sitka spruce forest, 49° 03′ N, 125° 43′ W, *Godfrey & Godfrey 2674,* 24 Jun 1975 (UBC). Pacific Rim National Park, behind Long Beach, Sitka spruce forest, 49° 03′ N, 125° 43′ W, *Godfrey & Godfrey 2677,* 24 Jun 1975 (UBC). Pacific Rim National Park headquarters, on road to E, behind picnic site, *Pinus contorta - Sphagnum* bog, peaty rotting stump over pool, wet, open to part shade, 49° 03′ N, 125° 43′ W, *Godfrey & Godfrey 2717,* 25 Jun 1975 (UBC). Effingham Inlet, lower slopes of Mt. Amedroz, 49° 02′ N, 125° 09′ W, *Schofield, L. Donovan & T. McIntosh 75878,* 2 Nov 1980 (UBC). Ucluelet Area, Quisitis Point, 'Spooky Woods', up base of tree in forest, 48° 59′ N, 125° 39′ W, *Schofield 26583,* 4 May 1965 (UBC). N of Ucluelet, W central coastal wet *Thuja* forest, nearly level, poor drainage, humic gleysol, 48° 58′ N, 125° 33′ W, *Gagnon, Spiers & Palmer 81-87-4,* 12 Aug 1981 (UBC). Barclay Sound, Mayne Bay, S side, near Lyall Point, log on upper beach, 48° 57′ N, 125° 18′ W, *Schofield 43418,* 29 Oct 1970 (UBC). Barclay Sound, West Brabant Island, shaded log, 48° 57′ N, 125° 19′ W, *Schofield 43358,* 29 Oct 1970 (UBC). Ucluelet area, W central coastal dry *Thuja* forest, on thick folisol over bedrock, 48° 56′ N, 125° 28′ W, *Gagnon, Spiers & Palmer 81-88-3,* 13 Aug 1981 (UBC). Barclay Sound, Willis Island, NW end, rotten log of upper beach, 48° 55′ N, 125° 20′ W, *Schofield 43410,* 29 Oct 1970

(UBC). Barclay Sound, SW bay of Turtle Island, shaded forest cliff, vertical humus, 48° 54′ N, 125° 19′ W, *Halbert, Price & Doak 6944,* 29 Oct 1970 (UBC). Barclay Sound, SW Bay of Turtle Island, shaded decaying log, 48° 54′ N, 125° 19′ W, *Halbert, Price & Doak 6949,* 29 Oct 1970 (UBC). E of Bamfield, coastal *Thuja* forest, level, poor drainage, 48° 50′ N, 125° 04′ W, *Gagnon & Palmer 80-57-7,* 14 Aug 1980 (UBC). E of Bamfield, Mile 58 near pond, up tree base, 48° 50′ N, 125° 08′ W, *Schofield 55372,* 30 Mar 1974 (UBC). Bamfield, Grappler Inlet, near old reservoir lake of Marine station, 48° 49′ N, 125° 08′ W, *Schofield, Donovan & McIntosh 75813,* 1 Nov 1980 (UBC). 'Rain Forest Trail', decaying stump, moist, partial shade, infrequent to abundant, 48° 42′ N, 124° 58′ W, *Godfrey & Godfrey 2777,* 26 Jun 1975 (UBC). 'Rain Forest Trail', western hemlock trunk; moist, partial shade, infrequent to abundant, 48° 42′ N, 124° 58′ W, *Godfrey & Godfrey 2778,* 26 Jun 1975 (UBC). Port Renfrew, high up on tree, 48° 34′ N, 124° 25′, *Gibbs s.n.*, 26 June 1901 (WTU).

USA

Alaska. Prince of Wales Island. Saltery cove, in flowing water, on rocks, 55° 24′ N, 132° 19′ W, *Frye 331*, 4 Jun 1913 (WTU). Prince of Wales Island, Exchange Cove, on stick in forest, 56° 12′ N, 133° 5′ W, *Frye 274*, 2 Jun 1913 (WTU). Prince of Wales Island, Ratz Harbor, on base o tree in very wet place, 55° 53′ N, 132° 35′ W, *Frye 293*, 3 Jun 1913 (WTU).

Oregon. Coos Co.: Cherry Creek Research Natural Area, N Fork Cherry Creek 20 miles SE of Coos Bay, (former) Big Tree Recreation Site, along road 27-11-27.0, on trunk of *Tsuga*, 43° 13′ 10″ N, 123° 56′ 5″ W, elevation 195 m, *Wagner 9051,* 4 Nov 1997 (OSC). Shotgun Creek, near junction of Road 26-9-21.0 and Road 26-9-17.0, riparian forest, 30 feet uphill from stream, bark of *Thuja plicata*, 43° 17′ 36″ N, 123° 45′ 41″ W, *Morgan 00-06*, 18 Apr 2000 (OSC). Shotgun Creek, about 0.5 mile above road BLM 26-9-21, *Pseudotsuga/Tsuga* forest, partial shade, *Thuja plicata* stump, 43° 17′ 47″ N, 123° 46′ 46″ W, *Sperling 00-JS-11*, *00-JS-12*, *00-JS-13*, 24 Apr 2000 (OSC). Unnamed stream off Burnt Mountain Tie Road, 26-10-35.0, *Pseudotsuga/Tsuga* forest, partial shade, *Pseudotsuga* short snag, 43° 17′ 16″ N, 123° 50′ 33″ W, *Sperling 00-JS-09*, 23 Feb 2000 (OSC). West Fork Smith River tributary, 12 miles above junction with Smith River, *Pseudotsuga/ Tsuga/Thuja* forest, partial shade, rotten *Thuja plicata* log, 43° 53′ 44″ N, 123° 43′ 32″ W, *Donato OR125/BRYO/DD015*, *OR125/BRYO/DD016*, 9 Mar 2003 (OSC). Slide Creek, Myrtlewood Resource Area, *Pseudotsuga/Tsuga* forest, partial shade, rotten *Thuja plicata* log, 43° 0′ 14″ N, 123° 55′ 16″ W, *Donato OR128/BRYO/DD013*, 4 Mar 2003 (OSC). West Fork Smith River tributary, 12 miles above junction with Smith River, *Pseudotsuga/ Tsuga/Thuja* forest, full sun, on trunk of *Thuja plicata*, 43° 53′ 52″ N, 123° 43′ 13″ W, *Barrett OR125/BRYO/BB-013*, 9 Mar 2003 (OSC). Tioga vicinity, unnamed tributary to Tioga Creek, 20 miles ESE of Coos Bay, 50 year old *Pseudotsuga menziesii* stand, *Thuja plicata* stump, 43° 15′ 48″ N, 123° 50′ 51″ W, *Sperling B2-JS-110*, 22 Oct 2002 (OSC). Burnt Mountain Road 27-10-1.1, fully shaded dry slope, bark of *Thuja plicata*, 43° 14′ 47″ N, 123° 49′ 45″ W, *Sperling B2-JS-113*, 24 Oct 2002 (OSC). Former Big Tree Recreation site adjacent to Cherry Creek Research Natural Area, riparian forest, bark of *Tsuga heterophylla*, 43° 13′ 10″ N, 123° 56′ 5″ W, *Rittenhouse 2125*, *2126*, *2127*, 16 Dec 1997 (OSC). Former Big Tree Recreation site adjacent to Cherry Creek Research Natural Area, riparian forest, bark of *Thuja plicata*, 43° 13′ 10″ N, 123° 56′ 5″ W, *Rittenhouse 2128*, *2128A*, 16 Dec 1997 (OSC). Hatcher Creek Area near Tioga, ca 20 miles ESE of Coos Bay, *Pseudotsuga/Tsuga/Thuja* forest, partial shade, *Thuja plicata* stump base, 43° 17′ 43″ N, 123° 49′ 27″ W, *Sperling 00-JS-03*, 7 Feb 2000 (OSC). Doerner Fir Trail, ca. 20 miles SE of Coos Bay, *Pseudotsuga/Tsuga* forest, full shade, bark of *Tsuga heterophylla*, 43° 10′ 52″ N, 123° 48′ 24″ W, *Pipp AP98-29*, 16 Dec 1998 (OSC). Camas Creek drainage, tributary to South Fork Coquille River, ca. 30 miles SE of Coos Bay. *Pseudotsuga/Tsuga* forest, partial shade, bark of rotting *Pseudotsuga* log, 43° 5′ 25″ N, 123° 46′ 14″ W, *Sperling CVS105-4*, 23 Oct 2002 (OSC). Douglas Co.: Panther Creek Bureau of Land Management regeneration site, fully shaded, riparian, bark of *Thuja plicata*, 43° 15′ 0″ N, 123° 36′ 52″ W, *Sperling 99-02JS*, 5 May 1999 (OSC). North Fork Coquille River Area of Critical Environmental Concern, N

side of Coos Mountain, 15 miles ESE of Coos Bay. *Pseudotsuga/Tsuga/Thuja* forest, riparian, partially shaded, on trunk of *Thuja plicata*, 43º 17′ 51″ N, 123º 53′ 30″ W, *Brown OR125/BRYO/KB002*, 5 Mar 2003 (OSC). North Fork Coquille River Area of Critical Environmental Concern, N side of Coos Mountain, 15 miles ESE of Coos Bay, *Pseudotsuga/Tsuga/Thuja* forest, riparian, partially shaded, On trunk of *Thuja plicata*, 43º 17′ 46″ N, 123º 53′ 27″ W, *Stidham OR125/BRYO/MS018*, 5 Mar 2003 (OSC). Camp Creek watershed, ca. 30 miles NE of Coos Bay, *Pseudotsuga/Tsuga/Thuja* forest, partial shade, near a seep, on rotten log, 43º 32′ 28″ N, 123º 42′ 11″ W, *Donato OR124/BRYO/DD014*, 8 Mar 2003 (OSC). Lane Co.: Gwynn Creek Trail, 700 m above trailhead, in vallley bottom. *Picea/Pseudotsuga/Tsuga* forest, full shade, *Pseudotsuga* down log, 44º 16′ 12″ N, 124º 5′ 45″ W, *Sperling, Rodenkirk, Roediger & Friedman B2JS109*, 16 Oct 2002 (OSC). Lincoln Co.: Cape Perpetua, Cape Creek Trail at bridge ca 100 m W of Giant Spruce. *Picea/Pseudotsuga/Tsuga* forest, full shade, bark of rotting *Pseudotsuga* log, 44º 16′ 52″ N, 124º 5′ 11″ W, *Rodenkirk, Sperling, Roediger, and Friedman 02TJRB1*, 16 Oct 2002 (OSC). Cape Perpetua, Cape Creek Trail at bridge ca 100 m W of Giant Spruce, *Picea/Pseudotsuga/Tsuga* forest, full shade, bark of rotting *Pseudotsuga* log, 44º 16′ 52″ N, 124º 5′ 11″ W, *Wagne r m3006*, 24 Feb 2016 (OSC). Cape Perpetua, Cape Creek Trail below visitor center, *Picea/Pseudotsuga/Tsuga* forest, full shade, on upper trunk of *Alnus rubra*, 44º 17′ N, 124º 7′ W, *Wagne r 1743*, 15-22 Jan 1978 (OSC). Cape Perpetua Scenic Area, Cape Creek Trail, on fallen log, 44º 17′ N, 124º 7′ W, *Wagner 2396,* 26 Jan 1980 (ORE, WTU). Cape Perpetua, Cape Creek Trail below visitor center. *Picea/Pseudotsuga/ Tsuga* forest, full shade, on upper trunk of Alnus rubra, 44º 17′ N, 124º 7′ W, *Wagner 1743*, 15-22 Jan 1978 (OSC).

Washington. Clallam Co.: Trail from Ozette Lake to Cape Alava, between lake and Ahlstrom's prairie, on trunk of *Picea sitchensis*, ca. 48º 10′ N, 124º 30′ N, *Schofield & Spence 77615,* 7 Jun 1982 (UBC). Olympic National Park, James Pond, on very moist, rotten log, 47º 55′ 10" N, 124º 36′ W, *Norris 98895*, 2 Jun 2000 (WTU). Grays Harbor Co.: Quinalt Lake, on trunk of *Taxus brevifolia*, *Brown & Muenscher* 7, 10 July 1950 (WTU). Quinault lake, Falls Creek campground, nature trail 1, old tree trunk, ca. 47º 30′ N, 123º 50′ W, *Schofield & Harpel 105194,* 28 May 1996 (UBC). Gattom campground, margin of lake Quinault, up base of tree, ca. 47º 30′ N, 123º 50′ W, *Schofield & Harpel 105231a,* 29 May 1996 (UBC). West Fork Humptulips River Watershed, Petes Creek Trail, on shaded *Abies* trunk, UTM Z10 444348 E, 5257460 N [47º 28′ 6" N, 123º 44′ 19" W], *Hutten 6193*, 25 July 2002 (WTU). Jefferson Co.: Goodman Creek Watershed, 6.5 miles south of Forks, state forest red cedar bog, on decaying *Tsuga heterophylla*, 47º 51′ 20″ N, 124º 24′ 25″ W, *Wagner m1120,* 29 Mar 2003 (OSC). Goodman Creek Watershed, 6.5 miles south of Forks; state forest red cedar bog site, wetland dominated by *Thuja plicata*, seepy hillside, on base of *Thuja*, 47º 51′ 20″ N, 124º 24′ 25″ W, *Wagner m1125*, 29 Mar 2003 (OSC). Snohomish Co.: Wisconsin creek, up base of tree in forest, *Schofield 21888,* 4 Jul 1963 (UBC). S Fork Stillaguamish River, 22 Creek near Verlot, 22 Lake trailhead, elevation 336 m, 48º 4′ 38″ N, 121º 44′ 45″ W, *Russell s.n.*, 27 March 1979 (ORE, WTU).

Appendix 2. Additional specimens examined, *Macrodiplophyllum flaccidum*

CANADA. British Columbia.

North Coast. Bear River, ca. 5 mi E of Hwy 37 crossing over river at Stuart, 30 mi W of Cranberry junction road, wet cliff, 55º 57′ N, 129º 58′ W, *Schofield 65102,* 6-10 Jun 1977 (UBC). Kaien Island, Prince Rupert, Hays Mountain, wet cliff, 54º 17′ N, 130º 18′ W, *Schofield & Boas 21535,* 14 Jul 1963 (UBC). Kaien Island, Prince Rupert, Hays Mountain, wet cliff shelf, 54º 17′ N, 130º 18′ W, *Schofield & Boas 21562,* 14 Jul 1963 (UBC). Kaien Island, Prince Rupert, Hays Mountain, damp cliff shelf, 54º 17′ N, 130º 18′ W, *Schofield & Sharp 25852,* 11 Sep 1964 (UBC). Kaien Island, Prince Rupert area, Hays Mountain, near summit, damp shaded cliff, 54º 15′ N, 130º 20′

W, *Schofield 72950,* 27 Jun 1979 (UBC). Kloiya Bay, ca 10 mi E of Prince Rupert, on cliff shelf, 54° 14′ N, 130° 11′ W, *Schofield 13858,* 14 May 1961 (UBC).

Haida Gwaii (Queen Charlotte Islands). N Graham Island, near center, Jalun Lake, central bank in forest near lake, 53° 58′ N, 132° 50′ W, *Schofield 35152,* 30 Jul 1967 (UBC). Frederick Island, NE side, damp cliff face, 53° 55′ N, 133° 10′ W, *Schofield 34239,* 26 Jun 1967 (UBC). Graham Island W, Boats River, near mouth, Port Louis, silty bank of river, 53° 42′ N, 132° 58′ W, *Schofield 34054,* 25 Jun 1967 (UBC). Graham Island, Mercer Lake, E end, near Athlow Bay damp cliff, 53° 35′ N, 132° 55′ W, *Schofield & Krajina 39698,* 26 Jul 1969 (UBC). Graham Island, V.J.K. Ecological Reserve, Athlow Bay, Port Chanal, Empire Ancorage-Goose Cove, 53° 35′ N, 132° 55′ W, *Godfrey & Godfrey 4155,* 8 Jun 1977 (UBC). SE side W Graham Island, Goose Cove, Athlow Bay, in Creek Canyon near sea stacks, humid shaded cliff face, 53° 35′ N, 132° 55′ W, *Schofield 33989,* 25 Jun 1967 (UBC). W. Graham Island, Goose Cove, Athlow Bay, damp cliff in canyon, 53° 35′ N, 132° 55′ W, *Schofield 64638,* 6-10 Jun 1977 (UBC). W. Graham Island, Goose Cove, Athlow Bay, shaded wet canyon wall, 53° 35′ N, 132° 55′ W, *Schofield & Spence 83653,* 8-9 Aug 1985 (UBC). SW Graham Island, Van Inlet, SW end, near mouth, damp shaded cliff face, 53° 15′ N, 132° 34′ W, *Schofield 33717,* 22 Jun 1967 (UBC). SW Moresby Island, Dawson Inlet, streamlet on NW side, damp streamlet margin, 53° 13′ N, 132° 29′ W, *Schofield 33483,* 20 Jul 1967 (UBC). NE Moresby Island, Alliford Bay, dampish cliff face, 53° 12′ N, 131° 58′ W, *Schofield 15745,* 28 Aug 1961 (UBC). SW Graham Island, Tana Bay, E side near head, shaded cliff, 53° 11′ N, 132° 21′ W, *Schofield 33514,* 21 Jun 1967 (UBC). S Graham Island, Trounce Creek, Trounce Inlet, cliff face, 53° 10′ N, 132° 19′ W, *Schofield 15590,* 26 Aug 1961 (UBC). Moresby Island, Skidegate Channel, Seaside cliffs of E narrows, wet cliff, 53° 09′ N, 132° 19′ W, *Schofield 14059,* 17 May 1961 (UBC). Moresby Island, canyon near S bay, Skidegate Channel, wet cliff, 53° 09′ N, 132° 05′ W, *Schofield & Sharp 25930,* 13 Sep 1964 (UBC). Moresby Island, N face Mt. Moresby, cliff shelf, 53° 08′ N, 132° 05′ W, *Schofield 25281, 25286,* 31 Jul 1964 (UBC). Moresby Island, N face Mt. Moresby, damp shaded cliff face, 53° 08′ N, 132° 05′ W, *Schofield 34467,* 1 Jul 1967 (UBC). Chaatl Island, shaded damp cliff near stream, 53° 07′ N, 132° 30′ W, *Schofield & Boas 18775,* 9-12 Jul 1962 (UBC). NW Moresby Island, Kitgoro inlet, shaded humid cliff shelf, 53° 05′ N, 132° 30′ W, *Schofield 30992,* 9 Jul 1966 (UBC). Moresby Island, Cirque Lake, SW side of Mount Moresby, damp cliff near falls, 53° 05′ N, 132° 00′ W, *Schofield & Spence 84237,* 18 Aug 1985 (UBC). Moresby Island, mountain between peak of Mount Moresby and W end of Mosquito Lake, damp cliff ledge, 53° 01′ N, 132° 07′ W, *Schofield 25403,* 1 Aug 1964 (UBC). Moresby Island, mountain between peak of Mount Moresby and W end of Mosquito Lake, seepy mountainside outcrop, 53° 01′ N, 132° 07′ W, *Schofield 32349,* 24 Jul 1966 (UBC). Moresby Mountain, base of N slope, Moresby Island, wet cliff ledge, 53° 01′ N, 132° 05′ W, *Schofield & Sharp 25905,* 12 Sep 1964 (UBC). Graham Island, Long Inlet, Lagins Creek, humid shaded cliff, 53° 00′ N, 132° 00′ W, *Schofield 29957,* 24 Jun 1966 (UBC). NW Moresby Island coast, Hibben Island, NE side, damp rock face, 52° 59′ N, 132° 20′ W, *Schofield 15246,* 22 Aug 1961 (UBC). Moresby Island NW, N slope of 'Laing Point' Mountain, NE side of Peel Inlet, wet terraces by waterfall, 52° 59′ N, 132° 05′ W, *Schofield 30273,* 28 Jun 1966 (UBC). Moresby Island, mountain at head of W. branch of Braverman Creek, Peel Inlet area, subalpine cliff crevice, 52° 59′ N, 132° 05′ W, *Schofield 30476,* 30 Jun 1966 (UBC). W Moresby Island, 'Laing Point' Mountain Range, Peel Inlet, subalpine cliff, 52° 59′ N, 132° 05′ W, *Schofield 34533,* 2 Jul 1967 (UBC). Moresby Mountain, Takakia Lake, about 10 mi S of Moresby logging camp, cliff shelf, 52° 55′ N, 132° 03′ W, *Schofield 25202,* 29 Jul 1964 (UBC). NW Moresby Island, Kootenay Inlet, bog near mouth of northern arm, damp cliff, 52° 50′ N, 132° 11′ W, *Schofield 31318,* 10 Jul 1966 (UBC). Moresby Island, Kootenay Inlet, S side near head of inlet, mouth of waterfall filled creek, 52° 50′ N, 132° 11′ W, *Schofield & Krajina 39582,* 23 Jul 1969 (UBC). Moresby Island, Tasu Creek mouth, head of Newcombe Inlet, Tasu Sound, up wet base of cliff, 52° 50′ N, 132° 08′ W, *Schofield 37623,* 4 Aug 1968 (UBC). Moresby Island, Mine Mountain above Tasu Townsite, Tasu Sound, wet cliff, subalpine area, 52° 46′ N, 132° 01′ W, *Schofield 37228,* 31 Jul 1968 (UBC). Moresby Island, Mine Mountain above Tasu

Townsite, Tasu Sound, damp alpine outcrop, 52° 46′ N, 132° 01′ W, *Schofield 37271,* 31 Jul 1968 (UBC). Moresby Island, Mine Mountain above Tasu Townsite, Tasu Sound, damp cliff, 52° 46′ N, 132° 01′ W, *Schofield & Schofield 73442,* 10-11 Jul 1979 (UBC). Moresby Island, Mine Mountain above Tasu Townsite, Tasu Sound, 52° 46′ N, 132° 01′ W, *Schofield 75021,* 26 Jul 1980 (UBC). Moresby Island, mountain directly above Tasu Townsite, wet cliff, 52° 46′ N, 132° 01′ W, *Schofield 34868,* 28 Jul 1967 (UBC). Moresby Island, Fairfax Inlet, Tasu Sound, W side near head, 52° 45′ N, 132° 00′ W, *Schofield 74924,* 9 Jul 1980 (UBC). SE Moresby Island, Bigsby Inlet, cliff crevices, 52° 37′ N, 131° 43′ W, *Schofield & Vaarama 24082,* 10 Jun 1964 (UBC). Huxley Island, N end, damp shaded cliff, 52° 28′ N, 131° 21′ W, *Schofield 44667,* 1 Jul 1971 (UBC). SE Moresby Island, Jedway area, damp cliff, 52° 20′ N, 131° 15′ W, *Schofield 34670,* 26 Jul 1967 (UBC).

South Coast and Coast Range. Namu Lake, near mouth of Barke Channel, boulder of stream margin, 51° 51′ N, 127° 51′ W, *Schofield 86169,* 4 Aug 1986 (UBC). Wakeman Sound, Kingcome Inlet, damp cliff near waterfall, 51° 00′ N, 126° 32′ W, *Schofield 41251,* 15 Apr 1970 (UBC). Toba Inlet, N shore, E of Brahm Bay, damp canyon cliff, 50° 25′ N, 124° 35′ W, *Schofield 38336,* 25 Feb 1969 (UBC). Slopes of Mount Matier, trail following three lakes, E of Pemberton, damp cliff in subalpine forest, 50° 20′ N, 122° 26′ W, *Schofield 56830A,* 7 Aug 1975 (UBC). Raza Island, centre, W side, Raza Passage, seasonal streambed, rock wall in ravine of stream, wet, N facing, open, 50° 18′ N, 125° 01′ W, *Godfrey & Godfrey 3828,* 25 May 1977 (UBC). Raza Island, W side, Raza Passage, damp cliff, 50° 18′ N, 125° 01′ W, *Schofield 64083,* 25 May 1977 (UBC). Elaho Area, Sims Creek Valley, Peaches and Penor Waterfall, outcrop shelf by fall, 50° 15′ N, 123° 35′ W, *Schofield & Taylor 118620,* 17 Aug 2001 (UBC). Coin Creek, waterfall at natural bridge, in Ashlu Creek Valley, above Ashlu Creek, on S side, sand and humus over cliff face, wet-spray, open, abundant, 49° 57′ N, 123° 26′ W, *Godfrey and Godfrey 3531, 3543, 3552,* 17 Oct 1976 (UBC). Jervis Inlet, below waterfall at creek mouth into inlet, extreme upper end of Queens Reach, humus over slate canyon wall, wet, dripping, open, NW facing, abundant, 49° 45′ N, 124° 10′ W, *Godfrey & Schofield 2002,* 3 Sep 1974 (UBC). Squamish Highway (99), 5 mi N of Deek's Creek, waterfall E of highway, soil over boulder on stream bank by waterfall, wet-spray, open, 49° 30′ N, 123° 15′ W, *Godfrey & Godfrey 2423,* 14 Apr 1975 (UBC). Chehalis River, Harrison Mills Road, Mile 15.1, above mouth of Chehalis Lake, roadside cliffs, soil over outcrop, moist-wet, part shade, NE facing, 49° 23′ N, 122° 01′ W, *Godfrey, Godfrey & Schofield 2576,* 1 Jun 1975 (UBC). Golden Ears Provincial Park, 'lake lookout' trail and main trail to 'Burma Bridge', large waterfall, over rock on cliff face, wet in spray, N facing, 49° 22′ N, 122° 30′ W, *Godfrey & Godfrey 3664,* 16 Apr 1977 (UBC). N Vancouver, Capilano Canyon, below Cleveland Dam, humid cliff face, 49° 21′ N, 123° 06′ W, *Schofield & Jamieson 41441,* 2 May 1970 (UBC). N Vancouver, Lynn Canyon Park, exposed rock surface of boulder, steep, < 1 cm soil accumulation, 49° 20′ N, 123° 01′ W, *van Velzen & Leong s.n.,* 16 Jun 1980 (UBC). N Vancouver, Lynn Canyon, Twin Falls Bridge, downstream, rock in crevice along stream, little soil accumulation, irregular rock surface, 49° 20′ N, 123° 01′ W, *van Velzen & Leong s.n.,* 18 Jun 1980 (UBC). N Vancouver, Lynn Creek Canyon, cliff face, 49° 20′ N, 123° 01′ W, *Schofield & Boas 18438,* 1 Jul 1962 (UBC). N Vancouver, Lynn Creek Canyon, sandy soil among rocks above bank of Lynn Creek, 49° 20′ N, 123° 01′ W, *Godfrey & Godfrey 209,* 27 Sep 1973 (UBC). N Vancouver, Lynn Creek Canyon, damp cliff face, 49° 20′ N, 123° 01′ W, *Schofield, Godfrey & Godfrey 67624,* 16 Feb 1978 (UBC). Vancouver area, Indian Arm, head, wet cliff of canyon, 49° 20′ N, 122° 55′ W, *Schofield 40550,* 7 Jan 1970 (UBC).

Vancouver Island. O'Connor Lake area, ca 8 mi SW of Port McNeill, 1 mi W of O'Connor Lake, steep stream bed with frequent water falls, soil over rock on shaded cliff, 50° 32′ N, 127° 17′ W, *Halbert, Price, Doak 5499,* 21 Jul 1970 (UBC). Robson Bight, Tsitika River mouth, damp outcrop by stream, 50° 28′ N, 125° 34′ W, *Schofield 85595,* 28 Jul 1986 (UBC). Kashult Inlet, at Wood Cove, limestone cliffs and waterfall, dripping limestone wall by stream, 50° 09′ N, 127° 18′ W, *Halbert, Price, Doak 7268, 7269, 7303,* 8 Jun 1971 (UBC). Brooks Peninsula, Jackobson Creek, W of

Jackobson Point, cliff by creek, 50º 08′ N, 127º 43′ W, *Schofield 82654,* 13 Aug 1984 (UBC). Nootka Sound, near mouth of Tahsis Inlet, N of Strange Island, wet cliff of canyon, 49º 44′ N, 126º 37′ W, *Schofield 40238,* 1 Oct 1969 (UBC). Muchalat Inlet, near mouth Houston River & tributary, shaded moist river canyon, 49º 38′ N, 126º 18′ W, *Halbert, Price, Doak 4716,* 10 Jun 1970 (UBC). Nootka Sound, S side of Zuciarte Channel, E of Discovery Point, humus of slope in forest, 49º 35′ N, 126º 32′ W, *Schofield & Halbert 40386,* 2 Oct 1969 (UBC). Kennedy River, on river, 28 mi W of Sproat Lake, dampish cliff, 49º 14′ N, 125º 23′ W, *Schofield & Boas 19062,* 21 Jul 1962 (UBC). Tofino Ucluelet Hwy, waterfall 23 mi E of junction, humid cliff near waterfall, 49º 14′ N, 125º 22′ W, *Schofield 38842,* 7 May 1969 (UBC). Barclay Sound, near head of Effingham Inlet, damp cliff, 49º 04′ N, 125º 09′ W, *Schofield 43541,* 30 Oct 1970 (UBC). Stoney Creek, ca 5 mi W of Port Renfrew, shaded boulders and cliffs along stream through moist Cedar-Hemlock rainforest, shaded cliff base, humus over vertical rock face, 48º 33′ N, 124º 32′ W, *Halbert & Price 2922,* 1 Jul 1969 (UBC).

USA

Alaska. Wrangell Island, along road about 8.5 mi s. of Wrangell, open roadcut facing W, hemlock forest and shrubs above roadcut, wet rocks, 56º 20′ 56″ N, 132º 20′ 19″ W, *Worley 7603,* 4 Jun 1968 (UBC). Wrangell Island, slopes above sawmill, about 5 mi S of Wrangell, small fen opening in forest, 56º 23′ 41″ N, 132º 20′ 7″ W, *Worley & Hamilton 7891,* 7 Jun 1968 (UBC). Mitkof Island, Mitkof Highway, ca 7 mi S of Petersburg, stream gully, damp cliff near cascade, 56º 44′ 16″, 132º 56′ 15″, *Worley & Schofield 8674,* 23 Jun 1968 (UBC). Sitka County, Indian River Trail, valley bottom in Sitka spruce forest, on soil, *Wagner m2797,* 20 Aug 2012 (OSC). Douglas Island, N Douglas road, fish creek, salmon stream with occasional rock walls in spruce-hemlock forest with nearby muskeg, on rock by stream, 58º 20′ N, 134º 34′ W, *Worley & Boas 11618, 11703,* 28 Aug 1968 (UBC). Prince of Wales Island, Craig vicinity, trail to Sunny Hay Mountain, between muskeg and 2000′ minor summit on ridge, wet rock crevices on N facing bluff, 55º 28′ N, 133º 6′ W, *Worley & Hamilton 6973,* 20 May 1968 (UBC). Revillagigedo Island, gorge of "second waterfall creek" by road N of Ketchikan, on shaded rocks, moist wall of gorge, 55º 30′ N, 131º 45′ W, *Worley & Hamilton 6239, 6250,* 12 May 1968 (UBC). Kenai Peninsula, Slim's Pass area, mountain above Wide Bay, humid shaded crevice of cliff, 57° 27′ N, 156° 30′ W, *Schofield & Talbot 115109,* 23 Jul 2000 (UBC). Whittier, shaded cliff grotto, 60°46′N, 148°39′W, *Schofield & Talbot 117623,* 5 Jun 2001 (UBC).

Oregon. Clatsop Co.: Saddle Mountain, N facing cliff, 45º 58′ 8″ N, 123º 41′ 41″ W, *Schofield & Lyford 72296, 72253,* 5 Jun 1979 (OSC, UBC). Saddle Mountain, slopes and peak, seepy n. facing cliff, 45º 58′ 8″ N, 123º 41′ 41″ W, *Schofield, Godfrey & Godfrey 68037b, 68052,* 22 Mar 1978 (UBC, OSC). Saddle Mountain State Park, slopes and peak of Saddle Mountain, damp N facing cliff, 45º 58′ N, 123º 41′ W, *Lyford 2117,* 5 Jun 1979 (OSC).

Washington. Snohomish Co.: Stillaguamish River, cliffs on bank, wet cliff base, *Schofield, Ireland & Boas 18448,* 4 Jul 1962 (UBC). Clallam Co.: Deer Lake trail, Soleduck Hot Springs area, cliff face, canyon of Soleduck Falls, 47º 57′ 4″ N, 123º 48′ 12″ W, *Schofield & Iwatsuki 28301,* 4 Oct 1965 (UBC).

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OROBANCHE ROBBINSII (OROBANCHACEAE), A NEW SPECIES OF PARASITIC PLANT FROM COASTAL CALIFORNIA

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ABSTRACT

A new species of *Orobanche* (Orobanchaceae) endemic to rocky coastal areas of California is described as *Orobanche robbinsii*. The investigations presented here corroborate and extend those conducted (but not previously published) by G. Thomas Robbins and Lawrence Heckard. The new species is allied to *O. californica* but is distinguished by its glabrous anther sacs, pallid corollas with shorter, less arched tubes with oblong, erect lobes, and its affinity for the host *Eriophyllum staechadifolium*. Chromosome counts of $2n = 24_{II}$ are presented.

The parasitic plant *Orobanche californica* Cham. & Schltdl. occurs along the Pacific Coast of North America, from the Queen Charlotte Islands in British Columbia to Baja California. Six subspecies are currently recognized, each of which occurs in distinct habitats, parasitizes a distinct suite of host plant species, and displays a varied but distinct morphology. Due to their small population sizes and brief appearance above ground, a body of specimens from which to refine range limits and make further morphological assessments has been slow to accumulate. Generations of botanists, including Beck von Mannagetta (1890, 1930), Munz (1930), and Heckard (1973) have contributed iterations of precision to the taxon boundaries of California *Orobanche* species, and the process continues with this paper.

Lawrence R. Heckard advanced our understanding of *Orobanche californica* by correcting misinterpretations of previously cited specimens, actively seeking new specimens, and acquiring chromosome counts (Heckard 1973; Heckard and Chuang 1975). In his 1973 circumscription, Heckard presented *O. californica* as a complex of six subspecies and segregated two species, *O. vallicola* (Jeps.) Heckard and *O. parishii* (Jeps.) Heckard, which showed the best discontinuity in morphology. In that work, he alluded to yet another morphotype in coastal California: "…and the maritime habitat common to most of them **is shared within their range only by a distinctive undescribed species at San Francisco and southwards"** (emphasis added).

Heckard had documented continued presence of this morphotype at the collection sites of Carlquist and of Stebbins, located additional sites (*Heckard 1750, 6725* [UC]), collaborated with Tsan Iang Chuang and Feng Mai Chuang to obtain chromosome counts from four sites, and had drafted a manuscript for publication around 1969. However, Heckard apparently was not convinced that he had gathered enough information, as he never published his manuscript, which came to light during research on the complex.

Heckard's annotations and notes in fragment packets on specimens that he thought belonged to this morphotype inspired field investigations by the first author, resulting in additional locations being documented and a more precise understanding of its habitat, host specificity, and range of variation. The information presented here includes both new investigations and the corroborated investigations of Heckard's manuscript. The combined result is, in our view, sufficient to propose this morphotype as a distinct species.

OROBANCHE ROBBINSII Heckard ex Colwell & Yatsk., **sp. nov.** **TYPE**: **USA. California**. San Francisco Co.: Parasitic on *Eriophyllum staechadifolium* Lag., on small rock slides on ocean cliff near Lands End, just below Lincoln Park, San Francisco; elev. ca. 150 ft, 13 Aug 1956, *G. Thomas Robbins 3730* (holotype: JEPS!; isotypes: GH!, JEPS!, NY!, CAS!). Figure 1.

Differing from *Orobanche californica* subsp. *californica* in its short, erect corolla tubes, pallid corolla both interior and exterior, oblong erect corolla lobes, and glabrous (or nearly so) anther sacs.

Annual plants 4–15 (–26) cm in overall length from below-ground host attachment to tip of above-ground inflorescence. Main axis simple or few-branched near base, succulent and fleshy, underground portion of stem thickened and tuber-like or elongate and swollen just above point of host-attachment. Stem glabrous below ground, densely glandular-puberulent distally, entire plant pale yellow, white, or tan, or infused with purple in exposed aerial parts. **Roots** few to many, fragile, sometimes with short bifurcations, forming an amorphous mass 1–2 cm in diameter around host attachment. **Leaves** 3–8 mm, spirally arranged, broadly rounded or deltoid, appressed, tips rounded to subacute, margins entire to finely erose. **Inflorescence(s)** compact, forming a low crown to a hemisphere or cluster in robust specimens (occasionally elongate where obstructed or shaded), the proximal flowers solitary, long-pedicillate, or 2 or 3 on axillary branchlets, the distal flowers nearly sessile. **Bracts** 5–10 mm, shape obtuse to acute, the tips often retuse or finely erose, erect to slightly reflexed distally. **Pedicels** 2–10 mm (proximal ones to 35 mm in robust specimens), bracteoles 2, similar to calyx lobes. **Calyces** 6–14 mm, slightly asymmetric, fused portion 1–4 mm, the lobes subulate to narrowly spathulate, sometimes bifid at tip, erect, pallid or tinged dark purple. **Corollas** (0.8–) 15–25 (–32) mm, exterior pallid, interior with pink or purple venation, sometimes also infused with color beyond the veins (especially Santa Cruz County populations), inconspicuously two-lipped, the margin of sinuses between upper and lower lips rounded, truncate, or narrowly notched, not acute, the interior surface glabrous, moderately glandular-puberulent externally. Corolla tube not distinctly arched or dilated dorsally, slightly constricted above the ovary and slightly widening toward the apex, most flowers held +/- erect. Palatal folds not prominent, cream to pale yellow, slightly inflated, glabrous. **Corolla lobes** ascending to somewhat outward-curved , sparsely glandular-puberulent internally. Adaxial corolla lobes 4–6 (–9) × 2–4 mm, oblong to lanceolate, apex rounded to obtuse or truncate, rarely acute, margins finely to moderately erose, the sinus dividing the two lobes 3–4 (–5) mm deep; abaxial lobes +/- equal, 4–6 (–9) × 2–3 mm, oblong to oblong-ovate, tips rounded to slightly truncate, rarely acute, margins sometimes erose, tips erect, slightly reflexed or slightly incurved. **Stamens**: filaments glabrous at base; anther sacs glabrous or with a few long hairs along thecae, included or somewhat exserted from tube, held below to above stigma. **Stigma** somewhat bilobed, irregularly crateriform with thick lobes. **Capsules** 8–10 mm, shorter than calyx, 2 valved. **Seeds** numerous, 0.3–0.5 mm, brown, +/-ovoid, faceted, favose. $2n = 48$.

Topotypes. **USA. California.** San Francisco Co.: Lands End, San Francisco, 22 Aug 1923, *Eastwood s.n.* (CAS). Sandy soil at Land's End, San Francisco, the region of the type locality [of *Orobanche californica* C. & S.], 7 Sep 1930, *Howell 5460* (CAS, GH, MO, RSA). Rocky slide near Land's End, below Lincoln Park, 30 Jul 1966, *Heckard & Raven 1543* (chromosome voucher) (JEPS). Rocky slide near Lands End, below Lincoln Park, 30 Jul 1966, *Heckard 1543a* (JEPS). Near Lands End, below Lincoln Park, at base of rocky cliff, along jeep road, elev. ca 150 ft, 30 Jul 1966, *Heckard & Raven 1542* (chromosome voucher).

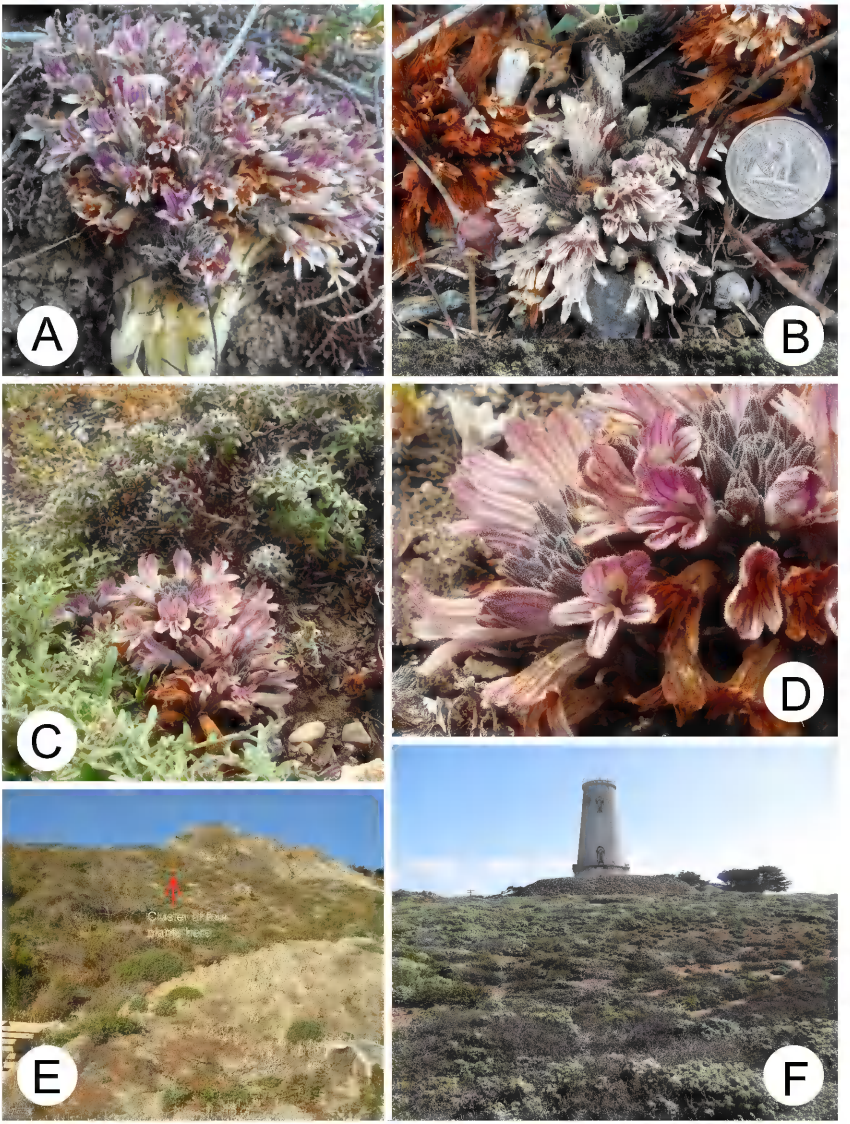

Figure 1. *Orobanche robbinsii* plants and habitats. **A.** Partially excavated plant near Presidio, San Francisco County. **B.** Plant with slightly narrower corolla lobes, near Carmel, Monterey. **C.** Flowering plant at base of *Eriophyllum staechadifolium* (from lighthouse area shown in Part F). **D.** Close-up view of flowers (same individual as in Part C); note the relatively straight (not recurved corolla, somewhat broader lobes. **E.** Bluffy slopes on W side of Presidio, San Francisco County (location of plant in Part A indicated with red arrow). **F.** Lighthouse area at Piedras Blancas, San Luis Obispo County, California. Photos by A. Colwell.

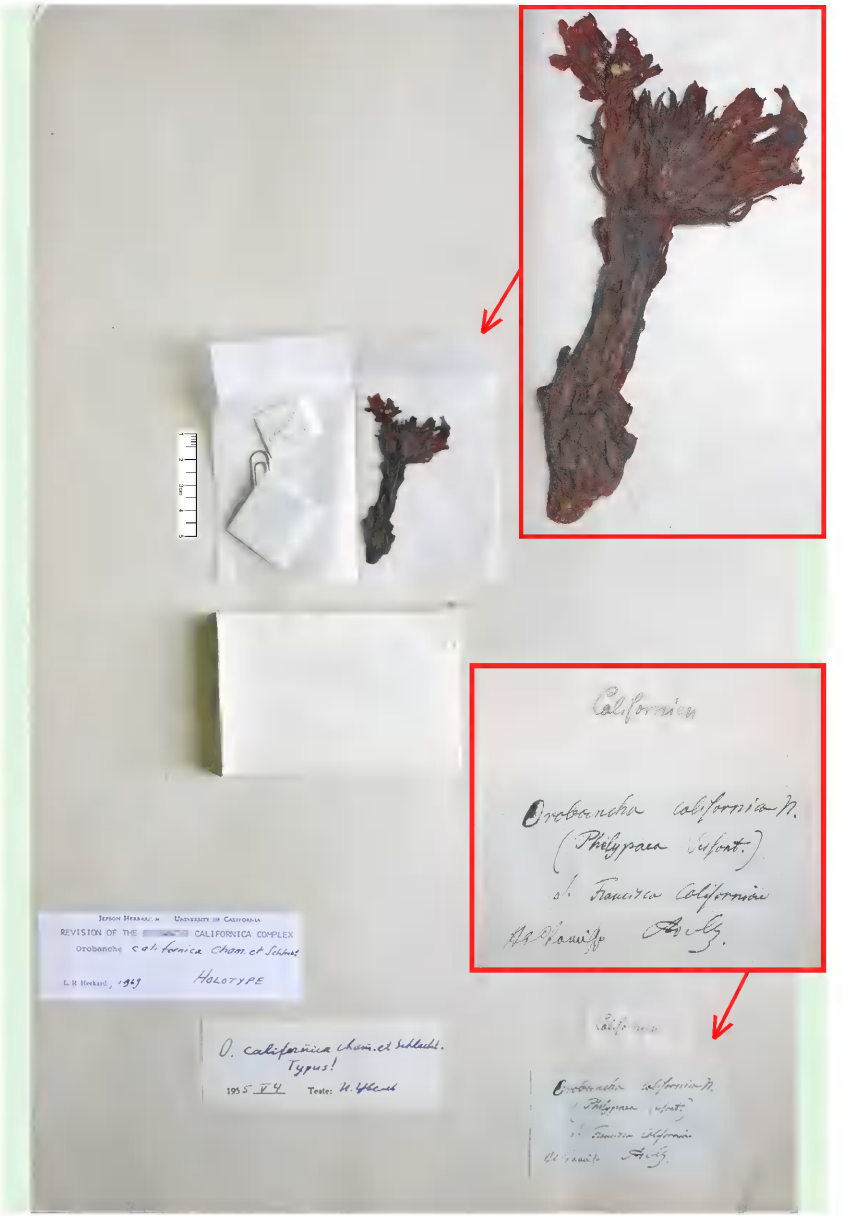

Figure 2. Holotype of *Orobanche californica* Cham. & Schltdl., Linnaea 3: 134–136. USA. California [San Francisco Co.], S. Francisco, *A. von Chamisso s.n.* in Aug [1816] (LE. Enlarged insets of label and plant are in red boxes. Photos by Barbara Ertter.

Table 1: Comparison of *Orobanche robbinsii* and related sympatric *Orobanche* taxa.

Species	Corolla Color	Corolla shape	Anther indument	Peak Flowering	Host(s)	Plant Community	Substrate
O. robbinsii	White to cream exterior and interior; interior lobes with pink or purple venation, occasionally also tinged pink	Tube straight to slightly curved, slightly dilated midway; upper corolla lobes oblong, erect at full anthesis, corolla 18-20 mm*	Anther sacs glabrous or occ with few long hairs	April-July	*Eriophyllum staechadifolium*	Coastal rock outcrops and rocky or sandy slopes at ocean, or slide material thereon	Crevices of metamorphosed ocean floor rock outcrops (Franciscan Complex), or gravel, scree or sandy soil derived from same.
O. californica subsp. *grandis*	Pallid to yellow exterior; interior of upper lobes infused pink to solid brick red, lower lobes paler with pink venation	Tube arched, abruptly dilated midway; upper corolla lobes flared, frilly, reflexed at full anthesis, lower lobes erect, corolla 25-30 mm*	Anther sacs woolly	July-August	*Lessingia filaginifolia, Isocoma menziesii var. vernonioides*	Coastal dunefields, especially in the lee of the foredunes	Semi-stabilized ocean sand dunes
O. californica subsp. *californica*	Solid lavender to solid red-purple exterior and interior, with darker venation	Tube arched, gradually widening; upper corolla lobes lanceolate to lance-ovate, diverging, recurved at full anthesis, corolla 25-55 mm*	Anther sacs woolly	August - September	*Grindelia stricta* var. *platyloba* and other *Grindelia* spp.	Coastal prairie, coastal bluff (Pleistocene marine terraces), coastal strand; estuary & lagoon borders	Ancient alluvial deposits, composed of clay, silt, sand and gravel

*measurements indicate overall corolla length from base of flower to tip of upper lobes.

Representative specimens. USA. California. County unknown: California, 1868–1869, *Kellogg & Harford 651* (NY, right-hand plant only). Coast Range, Central California, 1876, *Palmer 337* (YU). Monterey Co.: Point Lobos State Park, on *Artemisia pycnocephala*, sands, 16 Jun 1935, *Lee & Mason 9024* (UC). Along State Highway No. 1 between Little Sur River & Point Sur, bluffs facing sea in sandy soil, 31 May 1948, *Stebbins 3950* (UC); 27 Jun 1966, *Heckard 1600* (chromosome voucher) (JEPS). Coastal bluff just NW of restaurant, Rocky Point, S of Carmel, cleft in rock with *Corethrogyne californica, Eriophyllum staechadifolium*, coastal bluff, 27 Jul 1988, *Heckard & Taylor 6725* (fragment in packet; JEPS); Jul 2004, *Colwell & Taylor 04-313* (UC). San Francisco Co.: San Francisco, sand dunes, Aug 1914, *Miere s.n.* (CAS). Coastal dune, 26 July, 1922, *Degener s.n.* (NY). Above the Golden Gate to the E of Land's End, Lincoln Park, on crumbling rocky slopes. 5 Oct 1967, *Heckard 1750* (JEPS). San Luis Obispo Co.: 0.5 mi N of Piedras Blancas, on seaward face of bluffs, just above beach, 22 Apr 1951, *Carlquist 127* (DS, JEPS). Piedras Blancas, about ½ mi N of Point Piedras Blancas, same location as *Carlquist 127*, in sand of stabilized bluff about beach, 27 Jun 1967, *Heckard 1598* (chromosome voucher) (JEPS). Piedras Blancas Light House, native plant restoration area W of lighthouse, *Adams s.n. in 2014* (UC). San Mateo Co.: Pacifica, Shelter Cove, eroding faces of bluffs facing sea, 24 Jul 2014, *Colwell 04-*

196 (UC). Golden Gate National Recreation Area, Pacifica, W of Highway 1 at Mori Point, gravel bench at base of coastal bluff, 23 Jun 2013, *Schneider & Colwell 293* (JEPS). Santa Cruz Co.: Santa Cruz, Jun 1881, *Jones 242* (RSA). Sand Bluff, 4 mi N of Santa Cruz, on ancient shell mound, 28 May 2015, *Neubauer s.n.* (JEPS); 5 Jun 2015 *Colwell 15-006* (JEPS). Pigeon Point Light, in restoration area on lighthouse campus, 6 Jun 2015, *Colwell 15-007* (JEPS).

Additional specimens cited in the unpublished Heckard 1969 manuscript as at CAS, but not found during research for this paper. Marin Co.: Lime Point, 29 Jun 1921, *Eastwood s.n.* San Francisco Co.: Ingleside, on *Eriophyllum staechadifolium*, *Bergman s.n. in 1920.* The last was also cited by Howell et al. (1958).

Table 2. Comparison of *Orobanche robbinsii* with the *O. californica* type specimen at LE (an inflorescence from a single plant) and *O. californica* subsp. *californica* specimens from San Francisco and vicinity.

	O. robbinsii	***O. californica* type specimen (LE)**	***O. californica* subsp. *californica***
Main flowering period	April–July	October	Aug–October .
Anther sac vestiture	Glabrous or a few long hairs	Woolly	Woolly
Corolla color	White with pink or lavender veins, drying pale brown	Dried dark (apparently violet in color when fresh)	Lavender to violet, drying dark
Inflorescence	A corymb, few- to many-flowered, often congested	A corymb, appears to have at least ten flowers and buds, not congested	A corymb, few- to many-flowered, but not congested
Corolla length	15–23 mm	19–22 mm	22–30 mm
Corolla lobe length	3–4 (–8) mm	6–10 mm	5–13 mm
Calyx length	8–13 mm	11–15 mm	12–15 mm
Calyx lobe length	4–10 mm	6–9 mm	9–18 mm
Corolla throat	Barely constricted above ovary	Strongly constricted above ovary	Strongly constricted above ovary
Corolla shape	Upper corolla lobes with more or less parallel sides and evenly rounded or truncate apices; their shared notch is deep, half to nearly same length as upper lobes	Upper corolla lobes are slightly flared medially and their distal outer edge is tapered inward towards a shallow shared notch, shorter than upper lobes	Upper corolla lobes are slightly flared medially and their distal outer edge is tapered inward towards shallow shared notch, shorter than upper lobes
Sinus between upper and lower corolla lobes	Rounded	Acute	Acute
Position of upper corolla lobes	Erect, flared slightly at tips	Some indication of flared lobes	Flared, outer margins sometimes also recurved

Etymology

The specific epithet was chosen by Larry Heckard to commemorate G. Thomas Robbins (1916–1960), assistant to Rimo Bacigalupi at the Jepson Herbarium, University of California, Berkeley. According to Heckard, it was Robbins who first recognized the distinctness of this species. Heckard chose Robbins' 1956 collection as the type.

The genus *Orobanche* has heretofore borne the common name of broomrape, a name of European origin, which refers to the parasitism of some members of Fabaceae tribe Genisteae Dumort. (brooms) by species in the Eurasian sections of *Orobanche*. New World sections of *Orobanche* do not parasitize legumes. Therefore, we suggest an alternative common name: daisy-drops. This name refers to the primary host plant family (Asteraceae) for this and related *Orobanche*

species and to its flowering at the soil surface near its host. In the case of the plant described here, the suggested common name is Robbins' daisy-drops.

Ecology and distribution

The vegetative stages occur mainly underground, attached to host roots. Inflorescences appear above ground April through June in the southern part of the range, and in June and July farther to the north; rarely at other times of year in response to atypical rainfall patterns. Elevational range is 0–100 m.

This species is endemic to the central California coast. It occurs in sandy or gravelly openings among rocky outcrops, eroding slopes of seaside bluffs and on prehistoric shell mounds. Two specimens, *Miere s.n.* and *Degener s.n.*, also list sand dunes as habitat in San Francisco on their labels, but this requires confirmation.

Host relationships

Orobanche robbinsii has been confirmed by excavation multiple times to be connected to roots of *Eriophyllum staechadifolium* Lag. (Asteraceae: Heliantheae). *Eriophyllum staechadifolium* is the most frequently reported host on specimen labels. *Artemisia pycnocephala* (Less.) DC. (Asteraceae: Anthemideae) and *Phacelia californica* Cham. (Hydrophyllaceae) have been reported as the host on one specimen label each, and both species are frequent in *O. robbinsii* habitat. However, neither was physically confirmed to be the host.

North American *Orobanche* species tend to have one or sometimes two primary host species, although they will utilize other host species in cultivation (Hill 1892; pers. obs.), and occasionally a population will be found on a unique primary host species. Therefore, the host species (and its habitat) is an excellent identifying characteristic for these parasite species and care should be taken to obtain this information for herbarium specimen labels.

Taxonomic relationships

Relation to sympatric Orobanche californica subspecies. *Orobanche robbinsii* shares its coastal California distribution with two other *Orobanche* taxa: *O. californica* subsp. *californica* and *O. californica* subsp. *grandis* Heckard. Because these three taxa are sympatric, and populations of each are closely juxtaposed, recognition of their distinctness has been delayed. However, each has a distinct primary host species and is found on a distinct substrate type in a distinct plant community. Each has a different primary flowering time and differs in floral traits related to pollinator affinity, resulting in less opportunity for interspecific gene flow than a solely geographic distance measure would suggest. See Table 1 for a comparison of traits between these three taxa.

Schneider et al. (2016 in press) have recently studied the molecular phylogeny of New World *Orobanche* and included samples of *O. robbinsii.* They have confirmed that *O. robbinsii* is part of the *O. californica* complex. This might support describing the new taxon as a subspecies of *O. californica*, and indeed the taxon may be reclassified as such following more intensive studies. For now, we prefer to maintain it at the species level, both because of its unique host specificity and ecology and because the placement of O. robbinsii within the complex differed in trees generated using plastid sequence markers and those from nuclear markers, and thus has not been fully resolved. Future studies should focus on phylogenetic relationships of the *O. californica* complex using additional, more rapidly evolving markers.

Distinctness from the type of Orobanche californica. The type locality chosen for *Orobanche robbinsii* is in the vicinity of the type locality of *Orobanche californica,* described by Adelbert von Chamisso as: "…e vicinia portus St. Francisci Californiae…" (Heckard, 1973). Howell noted: "in the region of the type locality" on his 1930 collection (*Howell 5760*), and Robbins apparently thought his 1956 collection (*Robbins 3760*) matched descriptions of the Chamisso &

Schlechtendal type, as he put "Topotype" on his labels. However, the port of San Francisco at the time of the von Chamisso collection (1816) was in San Francisco Bay, surrounded by strand and estuary plant communities, a preferred habitat of *O. californica* subsp. *californica* and its host genus, *Grindelia* Willd. (Asteraceae: Astereae). In von Chamisso's (1836) account of his visit to San Francisco, he included repeated trips from his ship to the Presidio (he was functioning as the ship's interpreter) and a brief trip to the North shore of the bay on October 9, where he observed a "dry, arid field" and a "swamp" (red-brown rocks there siliceous schist). The rocky sea-bluff and sand dune habitat occupied by *O. robbinsii* and its host occur 3–5 miles west of the port location of that time, and southwards on the coast from the promontory of the "Golden Gate". Furthermore, it is *O. californica* subsp. c*alifornica* that would have been in bloom during von Chamisso's visit.

The holotype of *Orobanche californica*, a single inflorescence, is at the V.L. Komarov Botanical Institute, Saint Petersburg, Russia (LE). Heckard borrowed the type and examined it, and concluded that it is most similar to the plants that he treated as *O. californica* subsp. *californica* (Heckard 1973). In 2008, Barbara Ertter photographed photographed this type specimen while visiting LE (Fig. 2). Table 2 compares characters of this specimen with those of *O. californica* subsp. *californica* from the area and with *O. robbinsii.*

Note on corolla characters on herbarium sheets. Holoparasitic Orobanchaceae are succulent plants with strong oxidation activity when their tissue is cut or dried. Herbarium sheets therefore do not preserve the shape or the color of these plants well. In life, the corolla tube of *Orobanche robbinsii* is primarily pallid within and without, with purple or pink venation on the interior of the corolla lobes (Fig. 1A–D). In some plants, the upper lobes are also suffused with pale purple or pink (Fig. 1A, C, D). On herbarium sheets, the flowers of this species often dry dark, suggesting a deeper purple color than in life. Thus specimens can appear similar to those of *O. californica* subsp. *californica,* whose corollas (except where covered by the calyx) are uniformly reddish purple both inside and out, as their external and internal epidermal layers are composed of heavily pigmented cells. *Orobanche californica* subsp. *californica* tends to dry blackish purple or very dark brown (as is the case with the von Chamisso type). *Orobanche californica* subsp. *grandis*, in contrast, is strongly pink to brick red on the interior of the upper corolla lobes, with pallid lower lobes with pink veins, but this species is uniformly pallid on the exterior of the corolla due to the outer epidermal layer of cells lacking pigment. This trait can be seen on well-preserved herbarium specimens, the external epidermal cells of which maintain a 'frosted' appearance when viewed under a dissecting scope. This taxon tends to dry rust brown in less well-preserved specimens, although the deeper tint in the inside of the upper corolla lobes usually remains visible.

Infraspecific variation

As in other taxa in sect. *Nothaphyllon*, the size of *Orobanche robbinsii* plants varies considerably. Individuals in shallow, rocky soil present with compact, tuber-like belowground axes topped with many short, stout branchlets supporting a congested crown of few to many 1 cm-long flowers at the soil surface (Fig 1B). Such plants may be as small as 4 cm from host attachment to tip of inflorescence. Individuals that germinate in loose, deep soil and attach to robustly growing hosts, such as in fresh landslides or recently cleared sites, can exhibit an elongate, thick, fleshy, underground stem from a deeper host root attachment, either with a single flowering axis, or branched below the soil surface near the base of the axis, resulting in multiple adjacent crowns of flowers at the soil surface (Fig. 1A). Robust individuals (e.g., *Robbins 3730* [UC]) can be as long as 26 cm from attachment point to tip of inflorescence. The inflorescence in that case may present as a hemisphere of flowers at the soil surface, rather than a congested, flat crown (Fig. 1A).

Flower color and shape, as for other North American *Orobanche* species, is labile in this group, varying markedly between populations and even between individuals within a population. This variability could be an effect of genetic drift between these small, isolated populations or of

differential selection by local pollinators. The variation between plants is foremost a consequence of differences in vigor of the host plant, or of the particular host plant root to which the parasite is attached. Plant size, flower number, and flower size are especially a function of host vigor, depth of germination of the parasite and amount of light an individual receives upon surfacing. In contrast, the hue of the entire plant or corolla, corolla shape and corolla lobe margin type may be genetically controlled, with a high degree of variability between individuals, as evidenced by differences in these traits in plants attached to the same host either in the wild or in cultivation (personal observation). The degree of shading that plants receive may also factor into the amount of anthocyanin production.

Habitat

This species inhabits coastal bluff and slope habitat, in rocky or sandy soils, where its host plant, *Eriophyllum staechadifolium*, is frequent. Several of the known locations are on steep, eroding faces of sea-bluffs, on substrates belonging to the Franciscan Complex (metamorphosed rock derived from ocean floor and pelagic detritus) (Fig. 1E). The host plant occurs in seaside habitats from Coos County, Oregon, to San Diego County, California, but is most abundant and often dominant on Franciscan Complex substrate, between Del Norte and Ventura counties; within this region of host plant abundance additional populations of *Orobanche robbinsii* should be sought.

Conservation status

This new taxon has not yet been assessed for conservation status. This species has been documented to date in fourteen distinct locations (greater than 0.25 miles apart). Of these, ten are on county, state, or federal land. Two sites, Ingleside (*Degener s.n.* [NY]) and Sand dunes, San Francisco, (*Miere s.n.* [CAS]), have been converted to urban landscape and the *Orobanche* populations thereon likely have been extirpated. At the other twelve sites, there remains significant intact habitat where this species could persist or has been confirmed to be extant recently. A portion of this plant's past and potential habitat has been lost to non-native invasive plants (as is the case at type locality, where it has not been relocated in recent years), and to trampling associated with nearby development (Rocky Point and Lime Point locations). Removal of invasive species, or removal of vegetation followed by regrowth of the host species, has resulted in the reappearance of populations of *Orobanche robbinsii* at Piedras Blancas Light Station (Lewis and Adams 2009–2010), at Pigeon Point Light Station, and at the bluffs on the west side of the Presidio in San Francisco. Concentrations of rodents are a threat to *O. robbinsii* survival in some locations, such as at the Presidio, where most plants observed blooming in the past ten years have been devoured prior to setting seed.

With the exception of the restoration area at Pigeon Point Light, where more than 100 individuals were in bloom in 2015, fewer than 20 individuals have been observed to be flowering at any location, with 1–5 individuals typically observed at one time in a given location.

The typical habitat is steep, slippery with loose soil and rock, and difficult to access. Therefore, further inspection of likely habitat likely will reveal additional populations. However, due to the restricted amount of the preferred habitat (sparsely vegetated sea-cliffs with both a non-granitic rock substrate and abundant host plants), the number of occurrences of this plant are unlikely to be increased significantly. Therefore, the authors suggest the California Native Plant Society Rare Plant Inventory (http://www.cnps.org/cnps/rareplants/inventory/) consider this taxon for evaluation and eventual ranking.

Chromosome counts

Meiotic figure drawings and chromosome counts were made from four Heckard collections by Fei Mai Chuang in 1966 and 1967. A sample camera lucida drawing is used to illustrate these counts (Fig. 3). The methods were as reported in Heckard and Chuang (1975). All four collections

exhibit the diploid $n = 24$ number typical of sect. *Nothaphyllon*, and shared with most other California *Orobanche* species.

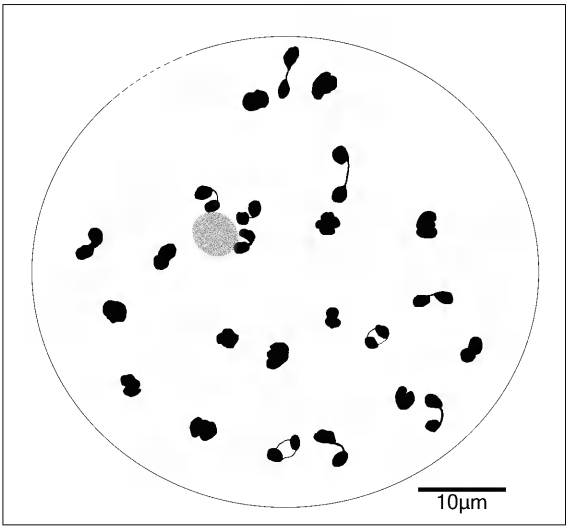

Figure 3. Camera lucida drawing at diakinesis of a representative meiotic chromosome count of *Orobanche robbinsii* $2n = 24_{II}$. Voucher: *Heckard & Raven 1543*. Other counts of $2n = 24_{II}$ are based on *Heckard & Raven 1542*, *Heckard 1598*, and *Heckard 1600*. All vouchers at JEPS. Original counts and camera lucida drawing by F.M. Chuang. See the exsiccatae for voucher locality data.

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CYPERUS TETRAGONUS AND *DESMODIUM TRIFLORUM*: NEW VASCULAR PLANT RECORDS FROM ALABAMA

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ABSTRACT

Two species of vascular plants are documented as new to Alabama: *Cyperus tetragonus* (native) and *Desmodium triflorum* (introduced). A complete set of the voucher specimens is housed at UWFP.

These two new records of vascular plants are reported for Alabama as a result of field studies. One of the species is native to the state. The second represents a non-native taxon established, at least locally, in the flora. Records were determined using the Alabama Plant Atlas (Keener et al. 2016), the North American Plant Atlas (Kartesz 2015), and searches of the literature.

CYPERUS TETRAGONUS Ell. (Figure 1)

Alabama. Baldwin Co.: Historic Blakeley Sate Park, edge of low woods along E side of Tensaw River, 30.747716° -87.924024°, 17 Aug 1985, *Burkhalter* & *Hedges 10057* (UWFP).

This represents the first report of this taxon from Alabama. It was not included in the Annotated Checklist of the Vascular Plants of Alabama (Kral et al. 2011), nor has it been included on the Alabama Plant Atlas website (Keener et. al 2016). *Cyperus tetragonus* is a native of the coastal states from North Carolina to Florida and also Arizona and New Mexico (Kartesz 2015). Tucker (2002) states that the status of *C. tetragonus* from the southwestern United States requires further study. The habitats include maritime forests, dunes and edges of brackish marshes along the Atlantic Coast from North Carolina to Georgia (Weakley 2015). In Florida, this taxon occurs in most counties in the peninsula and seven counties in the panhandle. The habitats include dunes, flood plains, hammocks, mesic hardwoods and xeric woodlands (Wunderlin et al. 2016). The North Carolina Natural Heritage Program (2014) gives this taxon a rank of S1 (extremely rare, often five or fewer occurrences, or, because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province). In South Carolina it has S2 rank (restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province) (South Carolina Heritage Trust Program 2014). NatureServe (2015) ranks this taxon as N4? (uncommon but not rare; some cause for long-term concern due to declines or other factors). The "?" denotes inexact or uncertain numeric rank. It is likely the N4 ranking is because of the abundance and wide distribution of this taxon in Florida.

DESMODIUM TRIFLORUM (L.) DC. (Figure 2)

Alabama. Baldwin Co.: Lillian, SW corner of US Hwy 98 and County Hwy 99, weedy, grassy roadside, 30.408314° -87.437247°, 28 Nov 2009, *Burkhalter 22570* (TROY, UWFP).

Desmodium triflorum is a pantropical species that has been introduced to subtropical and temperate regions in the southern United States (Isely 1990). In the United States, it occurs

throughout Florida (Wunderlin et al. 2016) and St. Tammany Parish, Louisiana (*MacDonald 8031,* VSC). In Florida, the first report of this taxon west of the Apalachicola River was from Escambia County on the University of West Florida campus (*Burkhalter 21256*, FSU, UWFP) (Kunzer et al. 2009). This represents the first report of this taxon from Alabama. It was not included in the Annotated Checklist of the Vascular Plants of Alabama (Kral et al. 2011) nor has it been included on the Alabama Plant Atlas website (Keener et al. 2016). This collection was made from a weedy, grassy roadside; associated species included *Dichondra carolinensis*, *Euphorbia hirta*, *Hypochaeris radicata*, *Pectis prostrata*, and *Plantago lanceolata.*

HERBARIUM OF THE UNIVERSITY OF WEST FLORIDA
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HERBARIUM OF THE UNIVERSITY OF WEST FLORIDA
Plants of ALABAMA
Cyperus tetragonus Ell.
Baldwin Co., E of Spanish Fort, In Historic Blakeley State Park. SW of Hiding Tree. Near edge of low woods along E side of Tensaw River.
17 AG 1985
Coll J. R. Burchalter & P. A. Hedges
Det JRB
No. 10057

Figure 1. *Cyperus tetragonus* from Baldwin County.

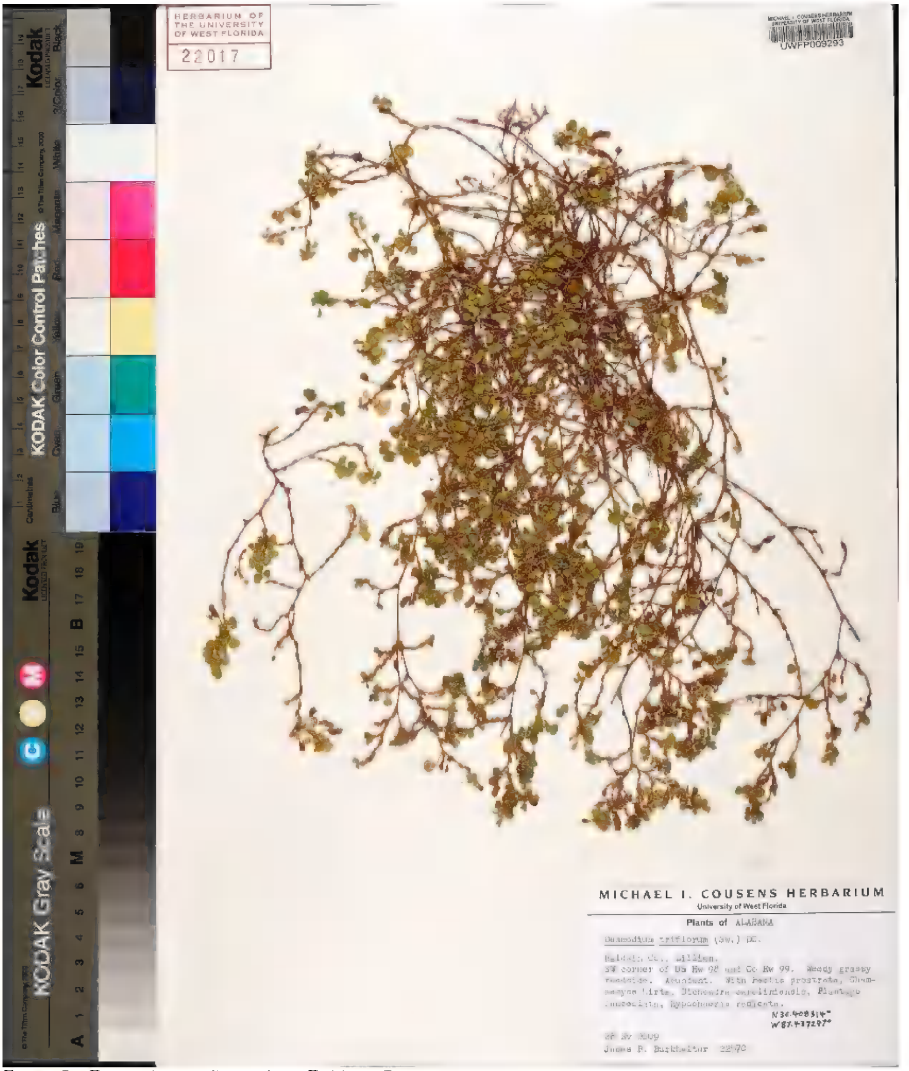

Figure 2. *Desmodium triflorum* from Baldwin County.

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A NORTH AMERICAN SPECIMEN OF *TROPAEOLUM PEREGRINUM* (TROPAEOLACEAE)

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ABSTRACT

A specimen of *Tropaeolum peregrinum* was collected from a beach of Devils Lake, North Dakota in July 1990 and deposited in the Olga Lakela Herbarium (DUL). This ornamental annual, native to the Andes Mountains, has apparently not been reported from outside of cultivation in North America north of Mexico. Major increases in the lake level soon submerged the likely collection sites. A search of the vicinities of those sites in July 2016 found no evidence of this species.

Tropaeolum peregrinum L., canary-bird flower or canary creeper, is thought to be native to the Peruvian Andes at 2500–3600 m elevations (Sparre & Andersson 1991). Planted as an annual for attractive yellow flowers and fast-climbing foliage, it seems not to have been reported from outside of cultivation in the continental United States or Canada (Tucker 2010; Kartesz 2015). I report the following collection for this species.

North Dakota. Ramsey Co.: lakeshore park on Devils Lake, sandy beach, probable escape from cultivation, 22 Jul 1990, *Monson 6308* (DUL).

The field notes from Paul H. Monson (1925–2003) have no additional information for this species there, lack further locational details for the other taxa that he collected at the same beach (as do their specimen labels), and indicate that specimens were not distributed to other herbaria. The single sheet has two pieces of shoot mounted on it, each with flowers and leaves, totaling about 30 cm long, with no roots. The combination of lobed leaves, deeply lobed petals, and hooked spur of the calyx is diagnostic (Sparre & Andersson 1991).

Beginning in 1993 the lake surface rose rapidly to be about 6 meters higher in 2000 than it was in 1990, then rose another 2.5 m or so before falling to be about 8 meters higher in July 2016 than it was in 1990 (USGS 2016). On 20 July 2016 I visited known current or former public sandy beach access sites on the Ramsey County side of Devils Lake, as inferred from maps, aerial images, and local inquiry. There were only two such sites, both of which have their former access roads permanently closed because of high water. I did not find *Tropaeolum peregrinum* at either of them, between the water's edge and the paved roads open to the public. The species could reasonably be regarded as extirpated there. Despite its widespread cultivation, *T. peregrinum* was not known by Sparre and Andersson (1991) to be naturalized outside of Peru, but it has more recently been recognized as naturalized in Europe (Clement & Foster 1994; Alanen et al. 2004).

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LIPANDRA POLYSPERMA VAR. *ACUTIFOLIA* (CHENOPODIACEAE): A CORRECTION AND VALIDATION

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ABSTRACT

Lipandra polysperma (L.) var. *acutifolia* (Sm.) Mosyakin (*Chenopodium acutifolium* Sm.) (Chenopodiaceae) is validated with the correct citation of the basionym. The combination was published invalidly (Art. 41.5 of *ICN*) in 2013, with an incorrect citation of Smith's publication. Corrected citations (grammatical gender, Art. 21.2 of *ICN*) of two section-level combinations in *Oxybasis* Kar. & Kir. are also provided.

Following the taxonomic re-circumscription of *Chenopodium* L. (Chenopodiaceae) and some other genera (including *Lipandra* Moq.) earlier usually considered synonyms of *Chenopodium* (Fuentes-Bazan & al. 2012), I proposed the new nomenclatural combination *Lipandra polysperma* var. *acutifolia* (Mosyakin 2013) for a widespread and rather distinct variety of the species. However, it has been done with an incorrect citation of the basionym: "*Lipandra polysperma* (L.) S. Fuentes, Uotila & Borsch var. *acutifolia* (Sm.) Mosyakin, comb. nov. *Chenopodium acutifolium* Sm., Comp. Fl. Brit.: 42. 1800." In fact, the cited publication did not contain the name *Chenopodium acutifolium*, which was published by Smith (1805) later.

According to Art. 41.5 of *ICN* (McNeill & al. 2010), "[o]n or after 1 January 1953, a new combination, name at new rank, or replacement name is not validly published unless its basionym or replaced synonym is clearly indicated and a full and direct reference given to its author and place of valid publication, with page or plate reference and date." Art. 41.8 of *ICN* is not applicable in this particular case. Consequently, the varietal combination in *Lipandra polysperma* has not been validly published by Mosyakin (2013).

This error in citation of the protologue was caused by widespread earlier erroneous citations of Smith's publication in taxonomic literature, starting probably from *Index Kewensis* (Jackson 1895). In this monumental and impressive nomenclatural compilation, the authors and compilers (quite naturally in pre-computer times!) greatly relied on earlier compilations. In particular, Meikle (1971: 298) noted that "Daydon Jackson did not attempt to trace all names to their original sources, but was content to accept the references given by De Candolle, Pfeiffer, Bentham and other eminent authorities. As a result many errors, some of them very serious ones, often affecting the priority of a name, were innocently incorporated in the Index." The same incorrect citation of the place of publication of *Chenopodium acutifolium* was reproduced in many taxonomic and floristic treatments, for example Iljin & Aellen (1936), Clemants & Mosyakin (2003) etc., and in such databases as Tropicos (2016) and IPNI (until October 2013, since then corrected).

The corrected citation and validation of the new combination are provided below.

Lipandra polysperma (L.) S. Fuentes, Uotila & Borsch var. **acutifolia** (Sm.) Mosyakin, **comb. nov.**
Chenopodium acutifolium Sm., Engl. Bot. 21: tab. 1481. 1805. *Chenopodium polyspermum* L. var. *acutifolium* (Sm.) Gaudin, Fl. Helv. 2: 259. 1828.

In the same article (Mosyakin 2013) I proposed new combinations for former sections of *Chenopodium* now transferred to *Oxybasis* Kar. & Kir. According to Art. 21.2 of *ICN*, plural adjectival epithets of subdivisions of genera should agree in gender with the generic name. Thus, in *Oxybasis* (feminine) the section names must have the feminine plural ending: *Oxybasis* sect. *Urbicae* (Standl.) Mosyakin (published as "*Urbica*") and sect. *Glaucae* (Standl.) Mosyakin (published as "*Glauca*"). The corresponding corrections (not affecting the validity of these names) were already made in IPNI in 2013 (Katherine Challis, personal communication in email to Sergei Mosyakin of 23 October 2013).

ACKNOWLEDGEMENTS

I am grateful to Katherine Challis, IPNI Editor (Herbarium, Library, Art and Archives; Royal Botanic Gardens, Kew), who already in 2013 noted the incorrect citation of Smith's protologue and the grammatical gender correction in *Oxybasis*; to Ray Angelo, Associate of Harvard University Herbaria, for urging me to validate the combination in *Lipandra* needed for the *Atlas of the Flora of New England*; and to Guy Nesom for his editorial work on the manuscript.

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LIRIOPE GRAMINIFOLIA (RUSCACEAE) NEW TO THE ARKANSAS FLORA, SECOND RECORD FOR THE USA

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ABSTRACT

Liriope graminifolia (L.) Baker is first reported here as new to the Arkansas flora and represents the first documented occurrence of the species in the state outside of cultivation and naturalized. Our record also apparently is only the second documented occurrence of *L. graminifolia* outside of cultivation in the USA. Thirteen distinct colonies of *L. graminifolia*, ranging from about a half-dozen plants to 100s of individuals and/or ramets, were discovered along a 3/10 of a mile (530 m) stretch of a small stream in a highly disturbed riparian habitat in Pulaski County. The Pulaski County location is bordered on two sides by residential areas. Two additional escaped occurrences of *L. graminifolia* in Clark County also are documented. Photographs of naturalized *L. graminifolia* in habitat are provided.

Liriope graminifolia (L.) Baker (grass lilyturf; creeping lilyturf — Figs. 1–2) is a stoloniferous perennial that is native to China, Pakistan, Taiwan, and Vietnam (Chen & Tamura 2000; Nesom 2010). In the USA, it previously only has been documented outside of cultivation in Texas (Nesom 2010; Kartesz 2015). *Liriope graminifolia* is reported here as new to the Arkansas flora and represents the first documented occurrence of the species in the state outside of cultivation and naturalized (Gentry et al. 2013; Serviss et al. 2016). Our record also is only the second documented occurrence of the species outside of cultivation in the USA.

Liriope graminifolia is regularly cultivated in much of the southeastern USA, including Arkansas (Hume 1961; Fantz 2008, 2009; Nesom 2010). Plants in cultivation typically produce extensive colonies via stoloniferous offsets (Nesom 2010; Serviss et al. 2016). This tendency of *L. graminifolia* to spread from source plants provides legitimate potential for escape and naturalization into areas adjacent to where plants of the species are cultivated (Serviss et al. 2016). Based on its regular occurrence in cultivation, stoloniferous habit, and ability for seed production, the discovery of *L. graminifolia* naturalized in Arkansas is not surprising.

Figure 1. *Liriope graminifolia* flowers, fruits (seeds with fleshy sarcotestas), inflorescences, and infructescences. (A–B) Close–up of flowers and young inflorescences. (C) Older inflorescence (notice the coloration has faded from purple to pale lavender). (D) Infructescences and nearly mature fruits. (E) Mature fruits — two, nearly black fruits may be seen in the photograph.

Figure 2. Naturalized plants of *Liriope graminifolia* from Pulaski County, Arkansas showing leaves, well–developed stolons, roots, and inflorescences (notice the inflorescences are equal in length or longer than the leaves — this aids in distinguishing it from the morphologically similar, *L. spicata* Lour. which typically has inflorescences positioned well below the leaves).

In 2016, 13 distinct colonies of *L. graminifolia*, ranging from about a half–dozen plants to 100s of individuals and/or ramets, were discovered along a 3/10 of a mile (530 m) stretch of a small stream in a highly disturbed riparian habitat in Pulaski County, Arkansas (Figs. 3–7). Naturalized *L. graminifolia* plants were observed growing in both semi–open and wooded areas. Plants were in flower and many ramets also possessed nearly mature fruits.

Figure 3. One of the larger colonies of naturalized plants of *Liriope graminifolia* from Pulaski County showing vegetative establishment via stoloniferous offsets (many offsets may be seen around the periphery of the main cluster of plants/ramets. Also, notice the plant of *L. muscari* (Dcne.) L. H. Bailey in the upper left corner of the photograph. Numerous naturalized individuals of *L. muscari* and the related *Ophiopogon japonicus* (Thunb.) Ker–Gawl. also were present at the Pulaski County site.

In one place of the Pulaski County site, plants of *L. graminifolia* were observed spreading from cultivated/persistent individuals of the species that were located at the edge of an unkempt yard. Spread appeared to have occurred a distance of several meters from the yard edge across an open area and through a portion of the adjacent woods of the riparian zone. While this observation attributes a plausible source and mode of establishment for one of the naturalized colonies of *L. graminifolia*, establishment of other colonies could be attributed to somewhat longer–distance bird– and/or water–mediated dispersal/transport of propagules (seeds and/or offsets). *Liriope graminifolia* is cultivated in a number of locations in Little Rock, including at least a few that occur within the vicinity of the naturalized plants. These plantings potentially provide a rich source of propagules. Subsequent spread and naturalization by *L. graminifolia* within the riparian zone probably occurred from a combination of stoloniferous offsets and seeds.

Figure 4. Plants/ramets from a portion of the largest observed colony of naturalized *Liriope graminifolia* from Pulaski County. This colony consisted of probably 100s of plants/ramets and extends from the edge of the riparian zone well into the woods along the stream. These plants appeared to have spread from individuals of *L. graminifolia* that were persistent from cultivation in an adjacent yard — spread from the persistent plants appeared to be predominately accomplished from stoloniferous offsets and occurred over a distance of several meters from the original area of cultivation.

Figure 5. Another, distinct colony of naturalized *Liriope graminifolia* from Pulaski County. The portion of the riparian zone where this colony occurs is a semi–wooded, flattened expanse just above the stream bank; this area contained several scattered colonies of *L. graminifolia*. A number of the plants/ramets in these colonies had nearly mature fruits.

Figure 6. Small colony of naturalized *Liriope graminifolia* from Pulaski County (distinct from those shown in previous figures). These plants were smaller than most of the others and appeared to have only recently produced flowers. This colony was growing in a flat, semi–open area near the edge of the riparian zone.

Figure 7. Similar colony of *Liriope graminifolia* to that shown in Fig. 6; this colony was smaller and the entirety of it is represented by the 10–12 ramets seen in the photograph. The ramets of this colony were still connected via stolons and it occurred in a mowed area at the edge of the riparian zone.

Additionally, we document a second occurrence of *L. graminifolia* outside of cultivation in Arkansas. Two small, escaped colonies of *L. graminifolia* were discovered growing in highly disturbed areas on the Henderson State University (HSU) campus in Clark County (Fig. 8). *Liriope graminifolia* is regularly cultivated on the campus and plants have been observed spreading from cultivated material via stoloniferous offsets (Serviss et al. 2016). Cultivated plants of *L. graminifolia* on the campus also produce fruit. The two colonies are separated by over 50 m and thus represent two independent escaped occurrences. The method of escape is unknown, although dispersal via seed is likely.

Figure 8. Escaped plants of *Liriope graminifolia* from Clark County, Arkansas. . (A) *Serviss 8361.* (B) *Serviss 8360.* Cultivated plants of the species are in the vicinity of both groups of escaped plants; however, spread from stoloniferous offsets is not likely as both groups are several meters from the nearest cultivated individuals. Rather, establishment via seeds probably occurred.

There appears to be an inherent degree of variation in regard to inflorescence length (including scape), flower and rachis coloration, and leaf width that occurs in Arkansas material of *L. graminifolia* — this variation may be observed in both cultivated and naturalized plants. Inflorescences may fade considerably subsequent to anthesis (Fig. 2A–C). Leaf width also is variable, from narrow and grass–like to considerably wider (see key below). Fantz (2008) and Nesom (2010) provide detailed descriptions of the species. Some photographs of cultivated *L. graminifolia* provided in the online appendix by Nesom (2010) show plants with very pale lavender to whitish–pink inflorescences, similar in color and form to much of the Pulaski County material. It is important to note, however, that horticultural selection, hybridization, polyploidy, or specific environmental factors, such as shading and available moisture, or some combination thereof, may have contributed to the variation observed in Arkansas material of *L. graminifolia* — identifications of some plants may be equivocal.

Liriope graminifolia is easily confused with *L. spicata* Lour., which is well–naturalized in Arkansas (Serviss et al. 2016). Overlap between the two species exists in regard to both vegetative and reproductive characters. *Liriope graminifolia* sometimes has wider leaves than *L. spicata* and is possibly less aggressive in regard to colonization and spread from stoloniferous offsets. These differences are supported by Fantz (2008) — attributed to *L. exiliflora* (L.H. Bailey) H.H. Hume, which is synonymous with *L. graminifolia* (Nesom 2010). Arkansas material of *L. graminifolia* and

L. spicata may be distinguished using the following key (in part, modified from Nesom 2010 — see also Fig. 9).

1. Scapes mostly equal to or taller than the leaves, (15–)20–44(–53) cm long, inflorescences conspicuous and often positioned well above the leaves, rachis of inflorescence (4–)5–13 cm long, flowers purple, lilac, or lavender, but flowers and rachis sometimes fading with age to pale lavender or pinkish–white; leaves variable in width, 2–12 mm wide ..... **Liriope graminifolia**

1. Scapes and inflorescences mostly shorter than the leaves and often obscured by them, scapes 12–29 cm long, rachis of inflorescence 2–5(–8) cm long, flowers white to pale pink or pale violet; leaves 3–8 mm wide ..... **Liriope spicata**

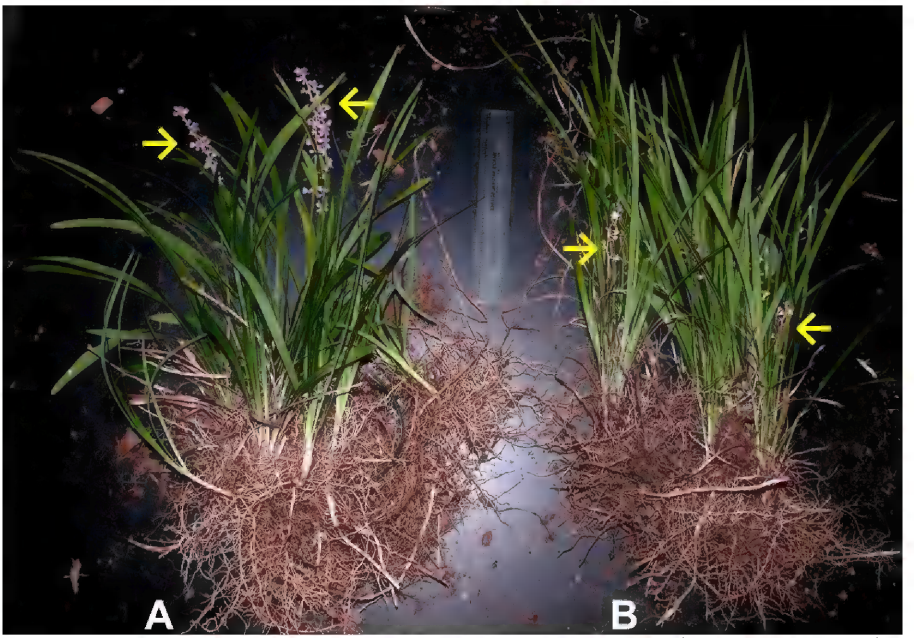

Figure 9. Comparison of reproductive plants of *Liriope graminifolia* and *L. spicata* (from cultivated material). Plants were growing in the same location at the same time when collected. (A) *L. graminifolia*. (B) *L. spicata*. Some inflorescences on both plants are designated with yellow–colored arrows. Notice both plants possess well–developed stolons; however, *L. graminifolia* has purple flowers and longer inflorescences that are positioned equal to or above the leaves, as compared to *L. spicata* with its white–colored flowers and smaller, shorter inflorescences that are positioned well below the leaves. Also notice the plant of *L. graminifolia* has slightly wider leaves.

Voucher specimens: **ARKANSAS**. Clark Co.: Small colony of escaped plants consisting of about 7 ramets in highly disturbed area near edge of Garrison Center, plants in flower, HSU campus, Arkadelphia, 23 Aug 2016, *Serviss 8361* (HEND); small colony of escaped plants in shaded, highly disturbed area immediately S of the Reynolds Science Building, plants in flower and spreading vegetatively via stoloniferous offsets, HSU campus, Arkadelphia, 10 Aug 2016, *Serviss 8360* (HEND). Pulaski Co.: Thirteen distinct, naturalized colonies present along a 3/10 of a mile stretch of stream and highly disturbed riparian zone, plants spreading vegetatively via stoloniferous offsets and

also possibly from seeds, many plants with flowers and nearly mature fruits, Hidden Valley Dr. between Rodney Parham Dr. and Pleasant Valley Dr., Little Rock, 2 Sep 2016, *Serviss 8367* (HEND).

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A NEW SPECIES OF LOBELIA (CAMPANULACEAE) FROM FLORIDA

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ABSTRACT

Lobelia apalachicolensis D.D. Spaulding, T.W. Barger, & H.E. Horne **sp. nov**., from the Apalachicola region of the Florida Panhandle has broadly elliptic to ovate leaves, toothed calyx lobes, and lower corolla lip densely pubescent basally. This new species shares many characters with *Lobelia georgiana* but has a calyx tube and corolla lip similar to *Lobelia glandulosa*.

In preparing a taxonomic treatment of *Lobelia* of Alabama and adjacent states (Spaulding & Barger, in prep.), a new species was discovered from Florida.

LOBELIA APALACHICOLENSIS D.D. Spaulding, T.W. Barger, & H.E. Horne, **sp. nov**. **TYPE: USA. Florida.** Liberty Co.: Apalachicola region of the Florida Panhandle, roadside ditch bordering wet pine flatwoods off SR-20 E of Hosford between SR-65 and SR-267, lat. 30.385199°, long. -84.754225°, elev. 95 ft., 18 Oct 2014, *D.D. Spaulding* and *M.A. Taylor 14223* (holotype: AMAL; isotypes: ALNHS, AUA, FSU, JSU, UNA, NCU, USF, UWAL).

Lobelia apalachicolensis is a tall, large-flowered species that is similar to *L. georgiana* McVaugh and *L. glandulosa* Walt. in that it possesses toothed calyx lobes with very small auricles or none at all. It is perhaps most phenotypically similar to *L. georgiana* because they both have ovate to elliptic leaves, but differs markedly from that species in several features that are found in *L. glandulosa*. Most importantly, the lower lip of the corolla is densely pubescent basally and the calyx tube can be either long-hirsute or glabrous like *L. glandulosa*. *Lobelia georgiana* has a corolla lip that is usually completely glabrous or rarely minutely pubescent basally and typically lacks hair on its calyx tube. *Lobelia glandulosa* differs from *L. apalachicolensis* by its linear to lanceolate leaves, geniculate (zigzag) stems, and usually darkens when dried; *L. apalachicolensis* has broad ovate to elliptic leaves (like *L. georgiana*), mostly straight stems, and dries light green. Populations of *L. puberula* Michaux with toothed calyx lobes can also be mistaken for *L. apalachicolensis*, but *L. puberula* has densely pubescent stems, calyx lobes, and corollas in contrast to the sparsely pubescent stems, glabrous calyx lobes, and usually glabrous or sometimes sparsely pubescent corollas of *L. apalachicolensis*.

Perennial herbs from basal offshoots with sticky, yellowish sap. **Stems** 0.85–1.9 m high (avg. 1.3 m); mostly simple, occasionally branched just below inflorescence; stems moderately to sparsely hirtellous or almost glabrous, usually more pubescent basally. **Leaves** alternate, simple, elliptic to ovate, thick and often fleshy; margins glandular toothed; leaf surfaces sparsely hirtellus to almost glabrous adaxially and moderately to densely hirtellous abaxially. **Flowers** epigynous (inferior), perfect, 1.8–2.5 cm long (avg. 2.0 cm); arranged in racemes that are often partially secund; pedicel with two linear bracteoles near the base (1–2 mm long); flowering time Sep–Nov. **Calyx tube** densely or sparsely chaffy-hirsute to glabrous with a pebbled, warty surface (both kinds may be observed within the same population); calyx lobes glabrous with prominent teeth along the margin; auricles none or very small and inconspicuous. **Corolla** purplish to blue; zygomorphic with 5 lobes; lips glabrous except for the villous base of lower lip on upper surface; corolla tube fenestrate, exterior surface glabrous or sparsely pubescent in lines. **Stamens** 5 and united into a tube; filament tube 7.5–10 mm long (avg. 9 mm); anther tube 3.5–4.5 mm long (avg. 4 mm). **Gynoecium** (pistil) with 2 carpels; style 1; stigma 2-lobed; ovules numerous; seeds ellipsoid with reticulate surface.

When this new species is keyed in McVaugh (1936), it stops at the couplet that includes *Lobelia glandulosa* and *L. glandulifera* (Gray) Small [= *L. georgiana*] (Fig. 1). *Lobelia apalachicolensis* cannot be keyed further because it has elliptic-ovate leaves and the lower lip of corolla is densely pubescent basally. McVaugh mentioned in his key that the calyx of *L. glandulosa* is often chaffy-hirsute, but he didn't mention the calyx of *L. glandulifera*. However, in his description of *L. glandulifera* he stated that the calyx is "smooth or rarely with a few hairs."

c. Plants usually weak; leaves 5–10, long-linear, to 0.5 × 15.0 cm., usually prominently denticulate. Flowers 1–10 (15), 20–33 mm. long. Lower lip of corolla hirsute at base. Filament-tube 8–10 mm. long. Calyx often chaffy-hirsute . . . . . 6. *L. glandulosa.*

cc. Plants slender or erect, smooth throughout. Leaves thick, lanceolate to oblong or ovate, to 3 × 7 cm., shallowly toothed or subentire. Flowers 6–20, 20–28 mm. long. Lip of corolla smooth. Filament-tube 7–8 mm. long. . . . 5. *L. glandulifera.*

Figure 1. Portion of *Lobelia* key from McVaugh (1936)

The first known collection of *Lobelia apalachicolensis* was made on 16 October 1954 by Robert K. Godfrey in Liberty Co., Florida, from a moist ditch bordering wet woodlands, about 3 miles east of Hosford. The type collection was made as close to this location as possible. Most specimens collected in the past were identified as *L. georgiana* [= *L. glandulifera*], but a few herbarium sheets were labeled or annotated as *L. glandulosa*, *L.* ×*rogersii* Bowden, or *L. georgiana* × *puberula*. *Lobelia apalachicolensis* was first thought by the senior author to be a possible hybrid between *L. glandulosa* and *L. georgiana*, but these two species were either absent or only *L. glandulosa* was present with *L. apalachicolensis*.

Collections examined (see Figure 2). **Florida**. Franklin Co.: [#1- originally det. as *L. georgiana*] in broad, shallow, wet ditches bordering pine flatwoods, 3.3 mi S of Liberty Co. line by Rt. C-67, N of Carrabelle, 8 Oct 1978. *Godfrey 76924* (FSU, BRIT); [#2- originally det. as *L.* cf. *georgiana*] stout plants with thick leaves, in ditch along highway 98 and bordering the Lanark Village golf course, 12 Sept 1984, *Anderson 7593* (FSU); [#3- originally det. as *L. glandulosa*] W of SR-319 ca. 1 mi S of Sopchoppy fire tower in ditch, 19 Oct 1989, *Johnson 8660* (FSU). Leon Co.: [#4- originally det. as *L. georgiana* × *puberula*?] wet roadside depression beside Rt. 375 just SW of Hwy 20, N side Soapstone Creek Bridge, 9 Oct 1995, *Larkin 95-38b* (MO). Liberty Co.: [#5- originally det. as *L. glandulifera*] moist ditch bordering wet woodland, about 3 mi E of Hosford, 16 Oct 1954,

Godfrey 52530 (USF). Wakulla Co.: [#6- originally det. as *L. georgiana*] scattered plants in low areas, edge of pine flatwoods alongside Fla. 375, 6.1 mi N of Sopchoppy, 18 Sep 1973, *Wooten 2271* (TENN, BRIT); [#7- originally det. as *L. georgiana*] along roadside of Fla 375, just S of Syffert Creek Bridge, 19 mi S of Leon County line, 13 Sep 1979, *Nelson 1348* (FSU, NCU); [#8- originally det. as *L. georgiana*] in boggy clearing at borders of titi bog, 5 mi N of Sopchoppy, by Fla. Rt. 375, 5 Nov 1980, *Godfrey 78256* (FSU); [#9- originally det. as *L. georgiana*] open, wet, peaty ditch, sphagnous area bordering pine flatwoods, Apalachicola National Forest, by Forest Road 365, NW of Crawfordville, 31 Oct 1981, *Godfrey 79253* (FSU); [#10- det. as *L. apalachicolensis*] roadside ditch, off Smith Creek Rd (CR-375) NW of Sopchoppy, *Spaulding & Taylor 14229* (AMAL).

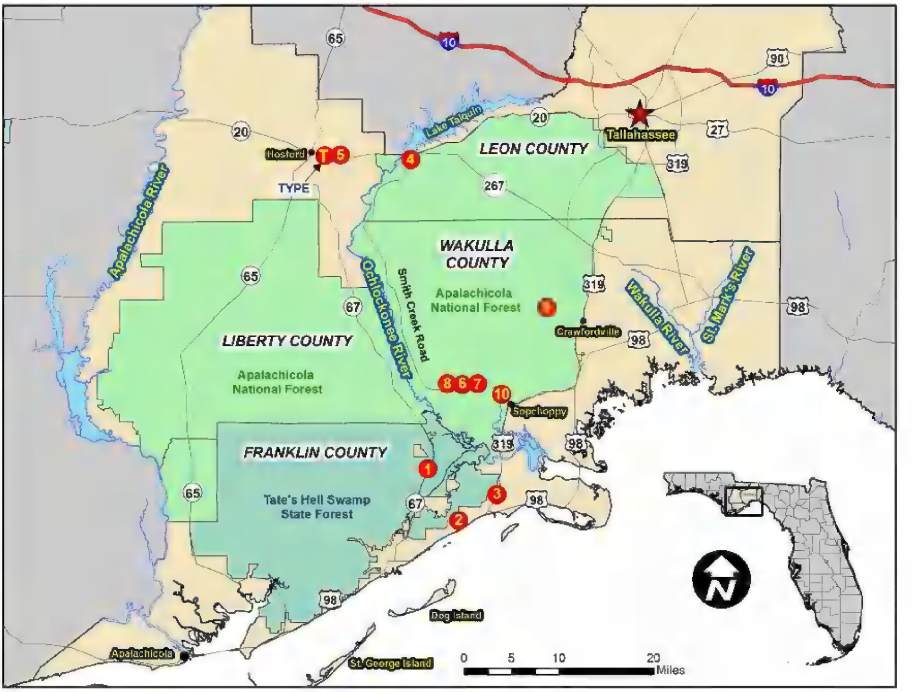


Figure 2. Sites of *Lobelia apalachicolensis* in Florida. Collections are marked in red circles.

Lobelia apalachicolensis is a Florida endemic known so far only from Franklin, Leon, Liberty, and Wakulla counties in the lower Ochlockonee River watershed (Fig. 2). Sorrie and Weakley (2001) observed that this area in the central panhandle of Florida flanking the Apalachicola River is known for its endemism and floristic richness. Clewell (1977) noted that there are 116 rare and noteworthy species in this area and that "nine are narrowly endemic within the watershed of the Apalachicola River, and 27 others are endemic to a somewhat larger region which includes the Apalachicola River area." Since Clewell's report in 1977, several new plant species have been described: *Sorghastrum apalachicolense* (Hall 1982), *Boltonia apalachicolensis* (Anderson 1987), *Hymenocallis godfreyi* (Smith & M. Darst 1994), *Hymenocallis franklinensis* (Smith et al. 2001), *Liatris gholsonii* (Anderson 2002), *Xyris panacea* (Anderson & Kral 2008), and *Hymenocallis gholsonii* (Smith & Garland 2009). *Lobelia apalachicolensis* represents another previously unrecognized and overlooked

endemic of this global biodiversity hotspot of the North American Coastal Plain (Noss et al. 2015). Due to the restricted range and number of populations of this species, it should be ranked as globally imperiled (G2) and imperiled within the state of Florida (S2).

Lobelia apalachicolensis (Fig. 3) is most commonly found in roadside ditches, but it also occurs along margins of wet pine flatwoods and shrubby (titi) bogs. This species is a hydrophyte and its wetland indicator status is most likely Facultative-Wetland (FACW). The specific epithet refers to the Apalachicola region of the Florida Panhandle and we have chosen the common name "Apalachicola lobelia" because many collections were made in the Apalachicola National Forest. The key below includes species of *Lobelia* from Florida with large flowers (>15mm long) and toothed calyx lobes that lack auricles or have inconspicuous ones at the base of the lobes.

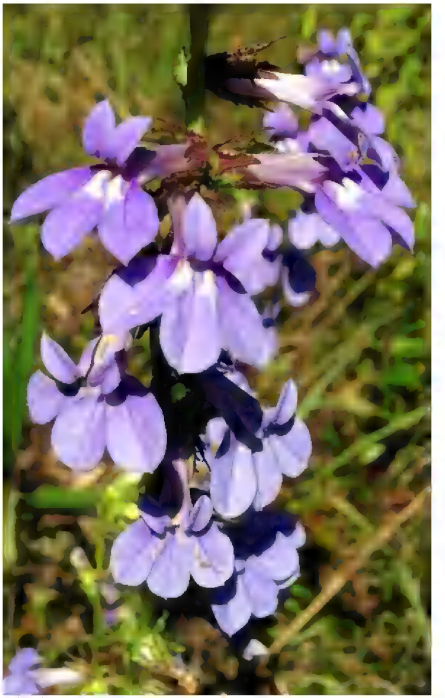
1. Stem leaves linear or lanceolate (all leaves less than 1.5 cm wide); internodes often geniculate (zigzag); plants usually drying darker; basal portion of lower lip of corolla densely pubescent ..... **Lobelia glandulosa**
1. Stem leaves ovate, elliptic, obovate, oblong or broadly lanceolate (most leaves much wider than 1.5 cm); internodes not geniculate or only slightly so; plants usually drying lighter; basal portion of lower lip of corolla either pubescent or glabrous.

    2. Stems densely pubescent throughout; margins of calyx lobes ciliate with sharp hairs; corolla tube exterior densely pubescent ..... **Lobelia puberula**
    2. Stems sparsely pubescent to glabrous (more pubescent at the base); margins of calyx lobes glabrous (lacking cilia); corolla tube exterior glabrous or sparsely pubescent in lines.

        3. Lower lip of corolla typically glabrous on upper surface near throat of tube, but occasionally papillate or minutely pubescent with very short hairs; calyx tube usually glabrous, rarely with a few scattered chaffy hairs; corolla tube exterior glabrous; ranges from Virginia south to Florida and west to Alabama ..... **Lobelia georgiana**
        3. Lower lip of corolla distinctly pubescent with villous hairs on upper surface near throat of tube; calyx tube long-hirsute to glabrous; corolla tube exterior glabrous or pubescent in lines; endemic to the Florida Panhandle..... **Lobelia apalachicolensis**

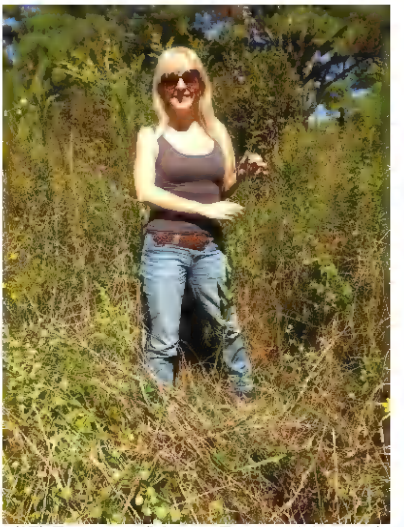
(3A) Habitat of type collection is a roadside ditch bordering wet pine flatwoods.

(3B) Inflorescence often secund.



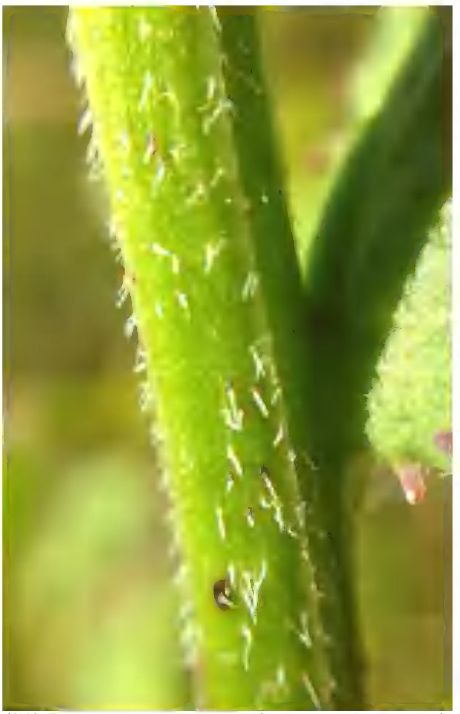
(3C) Flowers usually purplish in color.

(3D) Lower lip of corolla distictly villous at base.



(3E) Tall plants (Melanie Taylor = 1.6 meters).

(3F) Close-up of stem and inflorescence (the upper stems are sometimes glabrous).

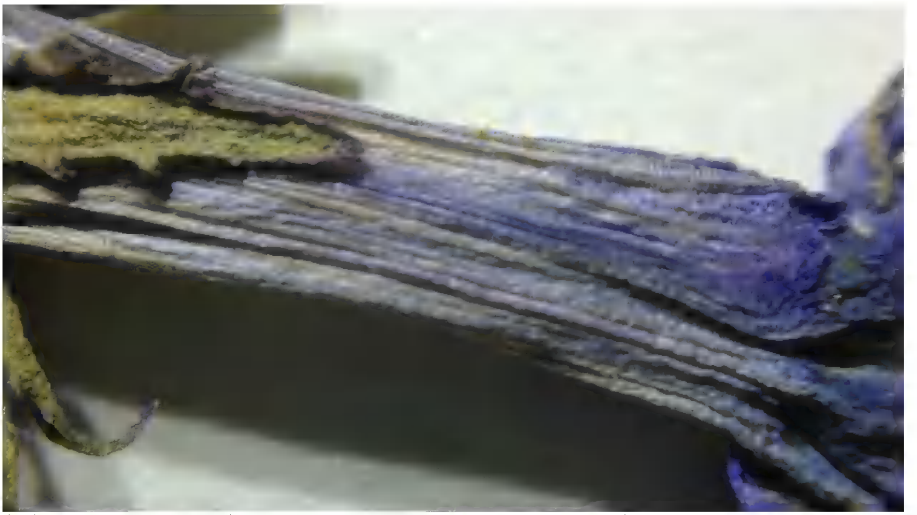


(3G) Sparsely pubescent stems (rarely almost glabrous).

(3H) Ovate-elliptical leaves.

(3I) Calyx tube densely long-hirsute (it can also be sparsely long-hirsute or glabrous).

(3J) Glabrous calyx tube with a warty texture.



(3K) Glabrous corolla tube (the calyx tube is either glabrous or chaffy-hirsute).

(3L) Sparsely pubescent corolla tube, with hairs in lines (the calyx tube will usually be densley chaffy- hirsute).

Figure 3. *Lobelia apalachicolensis* from type locality. (A-L) Roadside ditch bordering wet flatwoods, Liberty Co., Florida. (J-K) Herbarium specimen of type (AMAL), *Spaulding* & *Taylor 14223*, roadside ditch bordering wet flatwoods, Liberty Co., Florida. Photos by Dan Spaulding and Melanie Taylor, 18 Oct 2014.

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IBERIS UMBELLATA (BRASSICACEAE) AND *CYNOGLOSSUM AMABILE* (BORAGINACEAE) ADVENTIVE IN TEXAS

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ABSTRACT

Recent field studies in north Texas have resulted in the discovery of the two species here reported as adventive to the state. These include *Iberis umbellata*, a native of southeast Europe, and *Cynoglossum amabile*, a native of Asia. Both species are commonly used as garden ornamentals; both are reported here from a limestone glade in Soldier Springs Preserve in urban Weatherford, Parker County.

Iberis (Brassicaceae) is a genus of about 27–30 species (Rollins 1993; Al-Shehbaz 2010) of annuals, perennial herbs, and evergreen subshrubs native to Europe and southwest Asia. One species, *I. umbellata* L., a native of southeastern Europe, was reported by Al-Shehbaz (2010) as introduced to temperate North America, likely as a garden escape. The currently reported distribution in North America includes Quebec and Nova Scotia west to Ontario, Minnesota, Iowa, Wisconsin, Michigan, Ohio, Pennsylvania, New Hampshire, New York, and Maine in the east and British Columbia, Montana, California, Utah, and New Mexico in the west. Fourteen plants of *I. umbellata* were present at the location in Soldier Springs Preserve.

Figures 1–2. *Iberis umbellata* in flower at Soldier Springs Preserve, Parker Co., Texas.

Figure 3. *Iberis umbellata* in flower in front-right of *Schizachyrium scoparium* clump (just left of center) in a limestone glade at Soldier Springs Preserve, Parker Co., Texas.

Voucher. **Texas**. Parker Co.: Soldier Springs Preserve, 0.1 mi N of the junction of Mockingbird Ln and Mosley Ct on Mosley Ct, W side of Mosley Ct (32° 44' 37.18"N, 97° 48' 35.20"W), limestone glade, 14 plants found, 21 May 2016, *J. Singhurst* and *R. Singhurst 21041* (BAYLU). Figures 1-3.

Cynoglossum (Boraginaceae) is a genus of about 55 species of biennials, perennials, and rarely annuals distributed worldwide. USDA NRCS (2016) records six species as being introduced into the USA and three species as native. Presently, *C. amabile* Stapf & J.R. Drumm., known as Chinese forget-me-not or Chinese hound's tongue, is mapped as being introduced in Massachusetts, New Hampshire, New York, Vermont, and Wisconsin (Kartesz 2016; USDA, NRCS 2016). The following specimen documents the occurrence of *C. amabile* in Texas. Thirty-seven plants of *C. amabile* were discovered in clay-loam soils of a limestone glade.

Voucher. **Texas**. Parker Co.: Soldier Springs Preserve, 0.1 mi N of the junction of Mockingbird Ln and Mosley Ct on Mosley Ct, W side of Mosley Ct (32° 44' 37.53" N, 97°48' 35.49" W), limestone glade, 37 plants found, 21 May 2016, *J. Singhurst* & *R. Singhurst 21042* (BAYLU). Figure 4.

Figure 4. *Cynoglossum amabile* in flower at Soldier Springs Preserve, Parker County, Texas.

Because both species are common garden ornamentals, it is probable that they originated at the locations in Texas as garden escapes. Soldier Springs Preserve is in urban Weatherford, Texas and adjacent to a neighborhood from which *Cynoglossum amabile* could have drifted over from a garden source. The glades where the species occurred are typical of north-central Texas in having gentle slopes, whitish soil, and surfaces strewn with small to medium-sized rocks (generally less than 30 cm) (Fig. 3). Typical vegetation of such sites includes *Aristida purpurea*, *Bouteloua curtipendula*, *B. hirsuta*, *B. rigidiseta*, *Erioneuron pilosum*, and *Schizachyrium scoparium*. Other associated species include *Bifora americana*, *Calylophus sp.*, *Centaurium texense*, *Cercis canadensis*, *Dalea aurea*, *D. reverchonii*, *Dysodiopsis tagetoides*, *Evax prolifera*, *Forestiera pubescens*, *Galium virgatum*, *Grindelia* sp., *Hymenoppaus sp.*, *Iva angustifolia*, *Juniperus ashei*, *Lindheimeri texana*, *Linum sp.*, *Mentzelia oligosperma*, *Mimosa* sp., *Muhlenbergia reverchonii*, *Opuntia sp.*, *Pediomelum cyphocalyx*, *P. linearifolium*, *P. reverchonii*, *Plantago sp.*, *Quercus fusiformis*, *Q. buckleyi*, *Rhus aromatica*, *R. glabra*, *Salvia engelmannii*, *Silphium albiflorum*, *Sisyrinchium ensigerum*, *Stenaria nigricans*, *Stillingia texana*, *Thelesperma filifolium*, *Torilis arvensis*, and *Yucca pallida*.

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A NEW SPECIES OF *CALYPTRANTHES* (MYRTACEAE) FROM COSTA RICA

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ABSTRACT

Previous collections of *Calyptranthes guanacastensis* have been misidentified as *C. chytraculia* (L.) Sw., which is the most closely similar species, but the two differ greatly in habitat type and morphological characters (see below). While carrying out field work and research activities by INBio-KRIBB-2015´s project in the Área de Conservación Guanacaste (ACG), we were able to collect abundant flowering material of this species. After studying its habitat and collections (including previous collections), we conclude that represents a distinct and previously undescribed species.

RESUMEN

Colecciones previas de *Calyptranthes guanacastensis*, habían sido mal identificadas bajo la especie *C. chytraculia* (L.) Sw., la cual es la especie más relacionada, sin embargo, ellas difieren significativamente en el tipo de hábitat y otros caracteres morfológicos (ver adelante). Mientras realizábamos trabajo de campo y actividades de investigación por el proyecto INBio-KRIBB-2015 en el Área de Conservación Guanacaste (ACG), logramos recolectar suficiente y buen material con flores de esta especie. Posterior a un estudio, de las características de su hábitat y el material recolectado (incluido unas pocas colecciones previas), concluimos que representa una especie nueva distinta y sin describir.

Calyptranthes is a tropical American genus of Myrtaceae that is distributed from the southeast USA (South Florida) down to northern Argentina, the Antilles, and the Bahamas. The genus comprises about 100 species; 6 of them occur in Costa Rica (Holst & Kawasaki 2007). It is distinguished from other Myrtaceae genera by its conspicuously calyptriform, circumscissile, and deciduous calyx that falls as a unit or stays attached to the hypanthium on a single point (Holst & Kawasaki 2007). Also, *Calyptranthes* are mainly shrubs or trees, vegetatively characterized by persistent dichotomously branching twigs.

We describe *Calyptranthes guanacastensis* as a new species, illustrate it, and compare it with closely related species.

CALYPTRANTHES GUANACASTENSIS N. Zamora, S. Kim, & R. Espinoza, **sp. nov. TYPE: COSTA RICA. Guanacaste**. Cantón La Cruz, Área de Conservación Guanacaste, Sector El Hacha, Estación Los Almendros, sendero al cerro El Hacha, rumbo a la Quebrada El Tigre, 11º 01' 43.2'' N, 85º 31' 31.6'' W, 300 m, 18 Mar 2015 (fl), *Zamora et al.* 7559 (holotype: CR; isotype: KRIB). Figures 1-2.

Confused with *Calyptranthes chytraculia* by its reddish or ferrugineous-pilose inflorescences but differing markedly by its much smaller leaves [(1.4–) 3–10(–12.1) x (1.5–) 2–5.3 cm] with obscure or weakly evident secondary veins (in vivo), the inflorescences less or sparsely yellowish or ferrugineous-pilose pubescence with angulate main axes and laxiflorous branches. Moreover, it differs greatly in its habitat type, which is strongly dry to humid seasonal, semidecidous to evergreen, gallery or riparian forest.

Shrub or small tree of 4–5 m tall; old twigs essentially glabrous, young parts with dense, very short, appressed, ferrugineous-sericeous pubescence. **Leaves:** petiole 5–10 mm long, caniculate, appressed ferrugineous-sericeous beneath; lamina (1.4–)3–10(–12.1) x (1.5–)2–5.3 cm, elliptic, apex obtuse, acute to short-acuminate, sometimes apiculate, base obtuse, both surfaces glabrous when mature, only sparsely ferrugineous-sericeous beneath along the costa near the base, lateral veins 10–16 per side, weakly impressed and flat above, brochidodromous and weakly elevated underneath, reticulation obscure on both sides. **Inflorescence** axillary panicles, in pairs or 3–4 per axil, 5.7–8.7 cm long, peduncle 2.5–4.3 cm long, axes angulate to quadrangular, densely appressed ferrugineous-sericeous to densely pilose; bracts 0.5 mm long, deciduous. **Flowers** white, sessile, hypanthium 2 mm long, pyriform to cupuliform, densely ferrugineous-pilose; **calyx** calyptriform, circumscissile, calyptra 1.5 x 1.5 mm, laterally attached, concave, deciduous; **flower buds** obovoid, apiculate; **petals** 0; **stamens** many, white; pistil ca 5 mm long, glabrous. **Fruits** rounded to globose or ovoid, 7 mm long, 7 mm wide, glabrous, surface minutely papillose, apex shallowly urceolate, dark purple when ripe; pedicel 1–2 mm long. **Seeds** not seen.

Flowering material has been collected from January to March; fruiting in June and August.

Studying collections at the National Herbarium of Costa Rica, we found that some previous collections (see exsiccatae below) of *Calyptranthes guanacastensis* were misidentified as *C. chytraculia* (L.) Sw. But they can easily be distinguished because the leaves of *C. guanacastensis* are much smaller with obscure or weakly evident secondary veins (in vivo) (Fig. 2, C-D), the inflorescences are less or sparse yellowish or ferrugineous-pilose pubescence with angulate main axes and laxiflorous branches (Fig. 2, A-B). In contrast, in *C. chytraculia* the leaves are normally much bigger (10–17 x 4–7 cm) with strongly prominent venation (below), inflorescence tend to be larger (7–14 cm) with cylindrical, densely dark-ferrugineous or dark reddish-pilose axes and with densiflorous or multiflorous branches.

Both species also differ greatly in habit types. *Calyptranthes guanacastensis*, so far as known, is restricted to the northwestern part of the Cordillera of Guanacaste, growing at the lower-middle (300-700 m) Pacific slope, in strongly dry to humid seasonal, semideciduous to evergreen, gallery or riparian forest patches (Fig. 3). *Calyptranthes chytraculia* occurs mainly at the lowland-middle (0-850 m) Caribbean slope (except, for a population in the Osa Peninsula, Southern Pacific slope). It is distributed in wet or rain forest habitats, sometimes along coastal flat swampy forests.

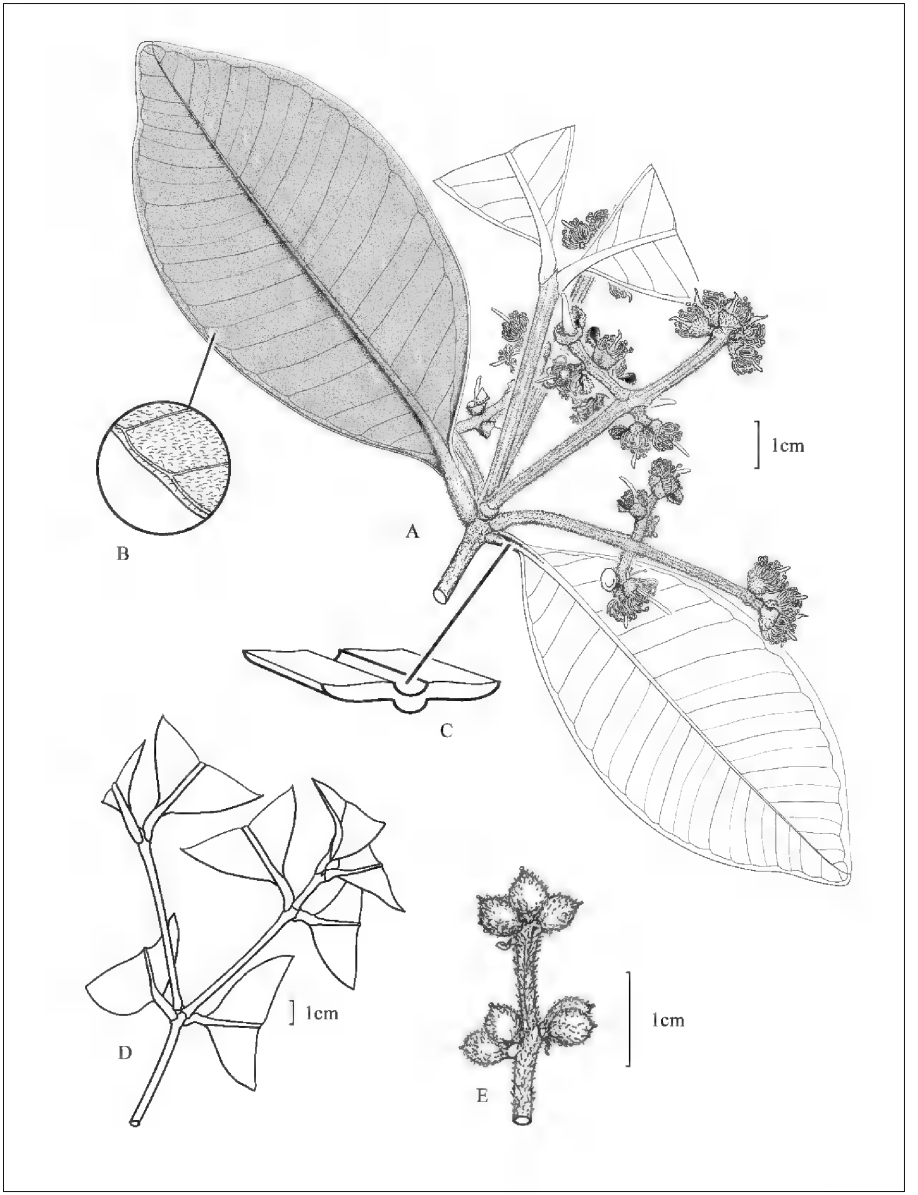

Figure 1. *Calyptranthes guanacastensis*. A. Twig with inflorescences. B. Submarginal vein and pubescence of lower surface. C. Petiole, channelled above. D. Dichotomously branching twig. E. Buds, showing apiculum and pubescence. Drawing by Claudia Aragón.

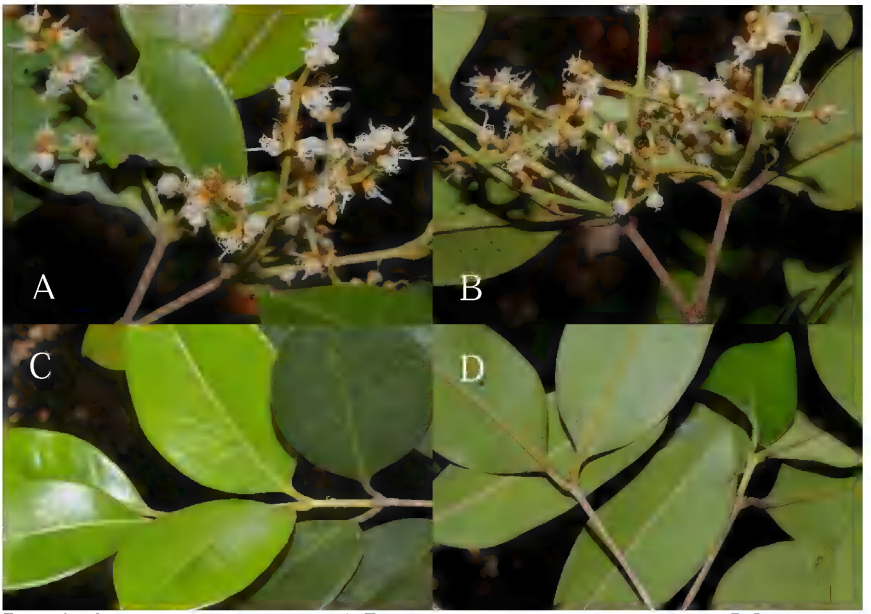

Figure 2. *Calyptranthes guanacastensis*. A. Terminal inflorescence showing the flowers. B. Inflorescences showing grouping at the twig´s apex. C. Leaves - upper surface. D. Leaves -lower surface. All from *Zamora et al.* 7559.

Figure 3. Landscape view of *Calyptranthes guanacastensis* habitat: dry semideciduous to evergreen seasonal forests patches along a watershed. Photograph by N. Zamora.

Additional material examined. COSTA RICA. Guanacaste: Liberia. Área de Conservación Guanacaste, Estación Cacao, Sendero Casa Frank, 10º 57' 20'' N, 85º 29' 21'' W, 620 m, 12 Ago 2014 (fr), *Zamora* et al. 7105 (CR, KRIB). Liberia. Parque Nacional Guanacaste, cuenca del Río Tempisque, Estación Maritza, Sendero a Cacao, 10º 57 06 N, 85º 28' 09'' W, 600 m, 12 Jun 1996 (fr). La Cruz. Parque Nacional Guanacaste, cuenca del Río Sapoa, Sector Los Almendros (El Hacha), sendero la Bejuquilla, 11º 02' 00'' N, 85º 31' 40'' W, 300 m, 21 Ene 1998 (fl), *Espinoza* et al. 1759 (CR). Liberia. Parque Nacional Rincón de la Vieja, cuenca del Río Tempisque, sector Los Almendros, 10º 45' 30'' N, 85º 19' 04'', 700 m, 2 Feb 1997 (fl), *Espinoza* 1664 (CR). Liberia, Parque Nacional Guanacaste, cuenca del Río Tempisque, Volcán Orosi, Estación Biológica Maritza, 10º 57' 19'' W, 85º 29' 29'' W, 650 m, 12 Mar 2003 (fl), *Boyle* et al. 7080 (CR).

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HYDRANGEA MACROPHYLLA (HYDRANGEACEAE) ADVENTIVE IN THE ARKANSAS FLORA

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ABSTRACT

Hydrangea macrophylla (Thunb.) Ser. is here documented as adventive in the Arkansas flora. This record is significant as no occurrences of this species outside of cultivation are known previously from Arkansas and also it represents only the second documented occurrence of this species in the USA flora. In 2016, several plants of *H. macrophylla* were discovered growing from horticultural discards in a rubbish heap in Clark County, Arkansas. The source of the plants apparently was stem cuttings that previously had been dumped at the site. Although small, plants were well–rooted with new vegetative growth and flowers when discovered. Another spontaneous occurrence of *H. macrophylla* is documented from Garland County. The Garland County specimen was obtained from a single plant discovered in a disturbed natural area along Hot Springs Creek; no evidence of prior cultivation was observed at the site. Photographs of plants and specimens from both counties are provided.

In 2016, several plants of *Hydrangea macrophylla* were discovered growing in a rubbish heap in Clark County, Arkansas (Figs. 1–3). The source of the plants apparently was stem cuttings that had been previously dumped at the site as horticultural discards. Although small, plants were well–rooted with new vegetative growth and flowers when discovered. Another spontaneous occurrence of *H. macrophylla* in Arkansas was documented by Peck in 2006 from Garland County (Fig. 4 — *Peck 06–326*). The Garland County specimen was obtained from a single plant discovered growing in a disturbed natural area of a wooded ravine and drainage along Hot Springs Creek. The spontaneous plant may have been escaped or possibly long–persistent from intentional planting by the Civilian Conservation Corps, a federal organization that was active in Hot Springs in the 1930s; Dirr (2004) noted that *H. macrophylla* may persist for decades subsequent to cultivation practices. However, no evidence of prior cultivation was observed at the Garland County site, and the area is diverse with naturalized exotic plant species. Water dispersal of stem segments generated from horticultural waste is a plausible explanation for the presence of the spontaneous plant, as *H. macrophylla* is commonly cultivated in Hot Springs and periodic flooding occurs along Hot Springs Creek, which could have transported and deposited such propagules to the site, allowing for establishment of the plant.

Figure 1. Adventive plants of *Hydrangea macrophylla* from Clark County, Arkansas. Each stem represents a separate plant; several may be seen in the photograph. Plants apparently were establishing from horticultural discards that were previously dumped at the site. Several large heaps of horticultural discards and lawn waste were present.

Although widely cultivated in the southern USA, *H. macrophylla* apparently does not readily escape cultivation and naturalize, and our records of adventive and spontaneous plants of *H. macrophylla* appear to represent only the second documented occurrence of this species in the USA distinct from intentional cultivation (Kartesz 2015; Weakley 2015; Jaster et al. 2016; USDA, NRCS 2016). Even in some other countries where *H. macrophylla* has been documented outside of cultivation, such as the United Kingdom, the presence of escaped or naturalized plants is uncommon (Preston et al. 2002). This seemingly limited capacity of *H. macrophylla* to escape from cultivation may owe in part to the large number of sterile flowers produced in many modern cultivars, which undoubtedly limits seed production. In addition, the absence of asexual propagules such as stolons, rhizomes, bulbs, and creeping roots also probably contributes to its relative inability to naturalize. The stems of *Hydrangea*, however, do readily produce adventitious roots and propagation of many *Hydrangea* species is accomplished easily through stem cuttings and air layering — this attribute provides a clear mechanism for the presence of the adventive plants observed in Clark County. Additional occurrences of adventive/spontaneous plants of *H. macrophylla* might be expected elsewhere in the state in areas where horticultural discards are deposited; however, future naturalization as a regular component of the flora or development into an invasive is not likely and it should probably be considered a waif, as defined by Nesom (2000). Interestingly, spontaneous occurrences of other important ornamental species arising directly from horticultural discards have been observed in Arkansas by one of the authors [BES], to include *Clerodendrum trichotomum* Thunb. (harlequin glorybower), *Colocasia esculenta* (L.) Schott (elephant's–ear, taro), *Lagerstroemia indica* L. (crepe myrtle), *Liriope spicata* Lour. (creeping lilyturf), and *Mahonia bealei* (Fort.) Carr. (leatherleaf mahonia), all of which, with the exception of *C. trichotomum*, are naturalized in the state's flora.

Figure 2. Close–up view of two of the adventive *Hydrangea macrophylla* plants from those shown in Fig. 1. Notice the well–rooted stems with numerous adventitious roots present where stems were previously buried within litter and debris.

Figure 3. Representative specimens of adventive *Hydrangea macrophylla* from Clark County (A & B).

J18978
HERBARIUM LRU — UALR's HERBARIUM
HYDRANGIACEAE
Hydrangia macrophylla
ARKANSAS: Garland County, along Hot Springs Creek in Hot Springs along Shady Grove Road.; waste areas, ditches and wooded drainage areas.
J. H. Peck 06-326 10 Sep 2006

Figure 4. Specimen of spontaneous *Hydrangea macrophylla* from Garland County, Arkansas.

Hydrangea is a genus of perhaps 25–30 species of deciduous or evergreen trees, shrubs, and lianas distributed primarily over eastern Asia, with a few species also in North America (McClintock 1957; van Gelderen & van Gelderen 2004), although Krüssmann (1977) and Wei and Bartholomew (2001) recognize more than 70 species. Several species of *Hydrangea* are prized as ornamentals for their showy, colorful flowers. *Hydrangea macrophylla* (Thunb.) Ser. (big–leaf hydrangea, French hydrangea), arguably the most important ornamental species in the genus, is a deciduous shrub to 3 meters that is native to Japan (Bailey & Bailey 1976; Krüssmann 1977). It is commonly cultivated in the southern USA, including Arkansas, and hundreds of horticultural varieties of it have been developed (Krüssmann 1977; Dirr 2002; van Gelderen & van Gelderen 2004). Two principal groups

of *H. macrophylla* cultivars occur — the *hortensias* or "mopheads," which have large, rounded inflorescences with tightly clustered flowers, nearly all of which are sterile, and the *lacecaps*, which have flattened inflorescences, where the outer flowers are showy and sterile and the centrally positioned flowers are small and fertile (Krüssmann 1977; Dirr 2004). Gradation between inflorescence types is observable across the range of cultivars (Dirr 2004).

Flowers range in color from almost red, to various shades of pink, blue, lilac, and purple, or occasionally white. In many cultivars, excluding most with red and white flowers, soil pH and the associated availability of aluminum, along with soil phosphorous levels may combine to affect flower color (Dirr 2004; Knox 2007); genetics of the particular cultivar or individual also contributes.

Hydrangea macrophylla may be distinguished from most other shrubs in the Arkansas flora by the combination of its large, coarsely toothed, thick–membranous, sometimes semi–fleshy leaves that are oppositely arranged, exfoliating bark, and large, showy pink, blue, purple, or occasionally white–colored flowers arranged in large, many–flowered, terminal inflorescences. It is most likely to be confused with the native *H. arborescens* L. (wild hydrangea); it may be distinguished from *H. arborescens* by its laminas that are cuneate at the base. In contrast, the lamina bases of *H. arborescens* are rounded to subcordate.

Voucher specimens. **Arkansas**. Clark Co.: Several plants adventive from rooted stem sections on rubbish heap, from horticultural discards, plants in flower, waste area at edge of ravine along 8th St. directly E of intersection of 8th St. and McNutt St., Arkadelphia, 16 Jun 2016, *Serviss 8346* (HEND). Garland Co.: One plant present in disturbed natural area of ravine and drainage along Hot Springs Creek, off Shady Grove Rd., Hot Springs, 10 Sep 2006, *Peck 06–326* (HEND).

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OCHO ESPECIES NUEVAS DE *LOBELIA* (CAMPANULACEAE) DE MÉXICO

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RESUMEN

Se describen e ilustran ocho especies mexicanas de *Lobelia* (Campanulaceae, Lobelioideae), todas o casi todas pertenecientes a la sección *Stenotium,* que se consideran como nuevas. **Lobelia ayersiae** Rzed., **sp. nov.**, del centro de Sinaloa, se integra al grupo caracterizado por el cáliz asimétrico y provisto de espolón y difiere de las demás especies conocidas del conjunto en sus hojas pinnatisectas. **Lobelia biflora** Rzed., **sp. nov.**, del centro de Veracruz, por su tamaño pequeño y reducido número de flores se compara con *L. schmitzii*, de la que se separa en ser planta perenne y más delicada. **Lobelia bipinnatifida** Rzed., **sp. nov.**, de la Sierra Madre Oriental de Hidalgo, está cercanamente vinculada con *L. subnuda*, pero descuella por sus hojas bipinnatisectas. **Lobelia corymbiformis** Rzed., **sp. nov.**, de la Sierra Madre Occidental de Durango, se asemeja a *L. orientalis*, aunque discrepa en ser planta anual, con fruto semi-infero y semillas lisas. **Lobelia divergens** Rzed., **sp. nov.**, de la Sierra Madre del Sur de Guerrero, muy probablemente está emparentada con *L. diastateoides*, de la cual se distingue en los segmentos del cáliz mayormente divergentes, así como en las anteras inferiores blancas, probablemente estériles. **Lobelia guzmanii** Rzed., **sp. nov.**, de la Sierra Madre Occidental de Durango, se relaciona con *L. gruina*, pero difiere en sus inflorescencias paniculado-corimbosas con menor número de flores. **Lobelia oaxacana** Rzed., **sp. nov.**, de la Mixteca Alta de Oaxaca, posiblemente se acerca a *L. diastateoides*, de la cual discrepa en sus numerosos tallos y en la coloración desigual de las corolas. **Lobelia subscaposa** Rzed., **sp. nov.**, de la Sierra Norte de Oaxaca, en sus hojas coriáceas y anteras menores sin pubescencia apical, no aparenta tener especies cercanas en México y es posible que no pertenezca a la sección *Stenotium*.

ABSTRACT

Eight new Mexican species of *Lobelia* (Campanulaceae, Lobelioideae), all or almost all belonging to sect. *Stenotium*, are described and illustrated. **Lobelia ayersiae** Rzed., **sp. nov.**, from Central Sinaloa, in the group characterized by both asymmetrical and spurred calyx, is unique in having pinnatisect leaves. **Lobelia biflora** Rzed., **sp. nov.**, from central Veracruz is similar to *L. schmitzii* in its small size and reduced number of flowers, but it differs in being a perennial and more delicate plant. **Lobelia bipinnatifida** Rzed., **sp. nov.**, from the Sierra Madre Oriental of Hidalgo, is closely related to *L. subnuda*, but it has bipinnatisect leaves. **Lobelia corymbiformis** Rzed., **sp. nov.**, from the Sierra Madre Occidental of Durango, is similar to *L. orientalis* but differs in being an annual with a semi-inferior fruit and smooth seeds. **Lobelia divergens** Rzed., **sp. nov.**, from the Sierra Madre del Sur of Guerrero, is very probably related to *L. diastateoides*, but it usually presents divergent calyx lobes as well as white and probably sterile lower anthers. **Lobelia guzmanii** Rzed., **sp. nov.**, from the Sierra Madre Occidental of Durango, is related to *L. gruina*, but it has paniculate-corymbose inflorescences with fewer flowers. **Lobelia oaxacana** Rzed., **sp. nov.**, from the Mixteca Alta region of Oaxaca, is possibly related to *L. diastateoides* but differs in its plentiful stems and unequal corolla coloring. **Lobelia subscaposa** Rzed., **sp. nov.**, from the Sierra Norte de Oaxaca, with coriaceous leaves and lower anthers lacking apical pubescence, does not appear to be related to any Mexican species of *Lobelia* and perhaps does not belong to sect. *Stenotium.*

El extenso y casi cosmopolita género *Lobelia* L. es también uno de los bien representados en la flora de México. Aunque carecemos de sus grandes elementos arbustivos y arborescentes característicos de las montañas de África, de acuerdo con Lammers (2011), poseemos componentes de cinco secciones del mismo, a mencionar *Cryptostemon, Homochilus, Lobelia, Stenotium y Tylomium.*

De la secc. *Stenotium*, que es la más numerosa en nuestro país, el mencionado autor reporta 49 especies del territorio de la República. El examen de los materiales acumulados en varios herbarios nacionales indica, sin embargo, que existe todavía una buena cantidad de elementos adicionales por registrar y describir.

A continuación se da a conocer la existencia de ocho especies nuevas, todas o casi todas pertenecientes a la citada secc. *Stenotium* (aproximadamente equivalente a la subsecc. *Leiospermae* de la más antigua clasificación de Wimmer (1953)), caracterizada por el hábito esbelto, corola azul, morada, rosada o blanca, hasta de 2.5 cm de largo, tubo estaminal exserto y barbadas las dos anteras inferiores.

LOBELIA AYERSIAE Rzed., **sp. nov.** TIPO: **MÉXICO. Sinaloa.** Municipio de Cosalá, a ca. 300 m de Guadalupe de Los Reyes; orilla de arroyo, vegetación selva baja caducifolia; suelo rocoso; alt. ca. 740 m; hierba erecta de 30-50 cm de alto, flores blancas, frecuente, 17.III.1985, *J. Adrián Beltrán M. 433* con J. Manuel Aguilar P. & Pedro Tenorio (ENCB). Figura 1.

Planta annua erecta ad 50 cm alta glabra; caules plerumque ramosi; folia omnia caulina plerumque numerosa profunde pinnatisecta 3-5(7) segmentis linearibus ad 2.5 cm longis et ad 1.5 mm latis; racemi laxi bracteis linearibus ad filiformibus ad 2 mm longis, pedicellis filiformibus ad 2.5 cm longis; hypanthium valde asymmetricum ca. 2 mm longum cum calcari cylindrico extus minus quam 1 mm longo, calycis lobi lineares ca. 1 mm longi, duo inferi ca. 2 mm sub tribus superis collocati; corolla alba tubo 1.5-2 mm longo labii superis lobis anguste triangularibus ca. 0.6 mm longis, labii inferis lobis spathulatis ca. 1 mm longis; filamentorum tubus ca. 2 mm longus, antherae parum quam 1 mm minores, inferae ad apicem barbatae; capsula ellipsoidea ca. 1 mm longa semiinfera; semina ellipsoidea ca. 0.5 mm longa, pallide brunnea laevia nitida.

Planta anual erecta, hasta de 50 cm de alto, glabra; tallos simples o con más frecuencia ramificados; hojas todas caulinas, por lo general numerosas, peciolos hasta de 1.5 cm de largo, pero con frecuencia casi ausentes, lámina profundamente pinnatipartida con 3 o 5(7) segmentos lineares hasta de 2.5 cm de largo y 1.5 mm de ancho, el terminal mucho más largo que los laterales, agudos a redondeados en el ápice, enteros o casi enteros en el margen, de textura membranácea; inflorescencias en forma de racimos terminales laxos, por lo común no secundifloros, con 5 a 15 flores, que en su conjunto forman especie de panícula, misma que a menudo ocupa más de 3/4 partes de la altura de la planta, pedúnculos hasta de 15 cm de largo, brácteas lineares a filiformes, hasta de 2 mm de largo, algunas provistas de bracteolas diminutas en la base, pedicelos filiformes, de 1 a 2.5 mm de largo, lisos, por lo general arqueados en el extremo distal; flores de ca. 7 mm de largo incluyendo el hipantio; éste de forma general campanulada pero muy asimétrico, de ca. 2 mm de largo del lado superior, de color café, del lado inferior extendiéndose junto con la corola hacia un espolón cilíndrico que se proyecta hacia fuera en menos de 1 mm de largo, pero en su totalidad mide unos 2 mm de largo de longitud a partir de la base de los segmentos superiores del cáliz; segmentos del cáliz lineares, de ca. 1 mm de largo, de margen entero, los dos inferiores ubicados ca. 2 mm más abajo que los tres superiores; corola blanca, tubo de 1.5 a 2 mm de largo, hendido casi hasta la base, sin aperturas adicionales, lóbulos del labio superior angostamente triangulares, de ca. 0.6 mm de largo, los del labio inferior espatulados, de ca. 1 mm de largo; tubo estaminal de ca. 2 mm de largo, anteras de poco menos de 1 mm de largo, glabras, salvo un mechón de pelos en el ápice de las inferiores;

cápsula elipsoide, de ca. 5 mm de largo, ínfera en 3/5 partes; semillas angostamente elipsoides, de ca. 0.5 mm de largo, cafés claras, lisas, brillantes.

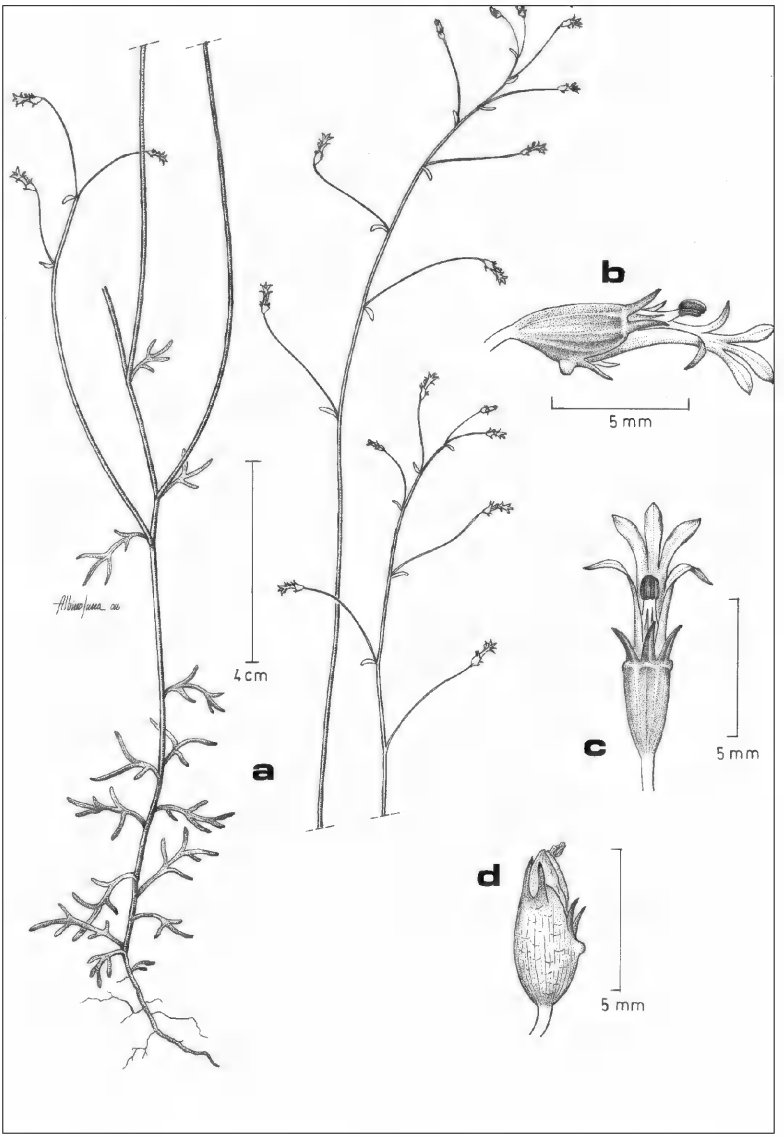

Figura 1. *Lobelia ayersiae.* A. Hábito de la planta. B-C. Dos vistas de la flor. C. Fruto. Ilustrado por Albino Luna.

Planta solo conocida de la localidad tipo ubicada en la porción central del estado de Sinaloa.

En virtud de sus flores asimétricas y provistas de espolón, *Lobelia ayersiae* pertenece al grupo de especies que durante mucho tiempo se incluían en el género *Heterotoma*, y más recientemente en *Calcaratolobelia* (Wilbur 1997), pero que, de acuerdo con los estudios de Ayers (1990) y Koopman y Ayers (2005), está más correctamente ubicado en *Lobelia*.

En su hábito anual y todas las hojas caulinas el taxon nuevo está relacionado con *Lobelia cordifolia* Hook. & Arn. y *L. volcanica* T. J. Ayers, pero difiere de éstas en ser planta glabra, con hojas pinnatisectas y lóbulos de la corola más pequeños. Es interesante hacer notar que Ayers (op. cit.) señaló que en ambas especies mencionadas a veces las hojas superiores pueden ser laciniadas a palmatipartidas, pero en realidad no tienen semejanza estructural con las de *L. ayersiae.*

El nombre de la planta se dedica a la Dra. Tina Jeanette Ayers, botánica norteamericana, quien realizó relevantes contribuciones al conocimiento de los representantes mexicanos de *Lobelia.*

LOBELIA BIFLORA Rzed., **sp. nov.** TIPO: MÉXICO. **Veracruz**. Municipio de Coacoatzintla, Cerro de La Magdalena, ladera cercana a la cima, 19º43'43'' N, 95º59'00'' W, bosque de pino y encino, alt. 2600-2650 m, 1.XI.2008, *P. Carillo-Reyes, M. Cházaro* y *D. Jimeno-Sevilla 5440* (IEB). Figura 2.

Planta herbacea perennis gracilis ad 15 cm alta; caulis unicus erectus vel ascendens simplex vel semel ramosus saepe filiformis; folia caulina irregulariter distributa petiolata saepe ovata 0.4-2 cm longa, 2-11 mm lata, margine leviter dentata et revoluta, hispidula vel subtus fere glabra; flores (1)2 longe pedunculati, bractea unica linearis ca. 2 mm longa, pedicelli erecti vel ascendentes 1-1.8 cm longi; hypanthium turbinatum ca. 1.5 mm longum et latum, calycis segmenti anguste triangulares integri ca. 1.5 mm longi; corolla ut videtur albo-rosea, tubo ca. 5 mm longo non fenestrato, labii superis lobis anguste linearibus ca. 4 mm longis, labii inferis lobis spathulatis ca. 5 mm longis; filamentorum tubus ca. 3.5 mm longus, antherae ca. 1.5 mm longae, inferae ad apicem barbatae; capsula seminaque non visa.

Planta herbácea perenne, delicada, hasta de 15 cm de alto; raíz profunda, muy delgada; tallo solitario, erecto o ascendente, simple o con una ramificación, a menudo filiforme, de menos de 0.5 mm de diámetro, hispídulo en la parte inferior con pelos de ca. 0.1 mm de largo, glabro más arriba; hojas todas caulinas, distribuidas en forma irregular, por lo general concentradas en un corto segmento del tallo, peciolo de 1 a 4 mm de largo, lámina foliar por lo común ovada, pero variando de elíptica a casi orbicular, de 0.4 a 2 cm de largo, de 2 a 11 mm de ancho, por lo general aguda en el ápice, cuneada a subcordada en la base, margen someramente dentado y algo revoluto, verde oscura e hispídula en el haz, sobre todo a lo largo de las nervaduras y hacia la periferie, más pálida y algo hispídula a casi glabra en el envés; inflorescencia conformada por (1)2 flores dispuestas en el extremo del pedúnculo de 2 a 6 cm de largo, bráctea una sola, linear, de ca. 2 mm de largo, pedicelos erectos o ascendentes, de 1 a 2 cm de largo, filiformes, glabros; hipantio turbinado, de ca. 1.5 mm de largo y de diámetro, glabro, segmentos del cáliz angostamente triangulares, de ca. 1.5 mm de largo, de margen entero, glabros; corola al parecer blanco-rosada, tubo de ca. 4 mm de largo, hendido casi hasta la base, no fenestrado, segmentos del labio superior lineares, de ca. 4 mm de largo y ca. 0.3 mm de ancho, los del labio inferior espatulados, de ca. 5 mm de largo y ca. 2.5 mm de ancho, tubo de los filamentos de ca. 3.5 mm de largo, anteras de ca. 1.5 mm de largo, el par inferior barbado en el ápice; fruto y semillas desconocidas.

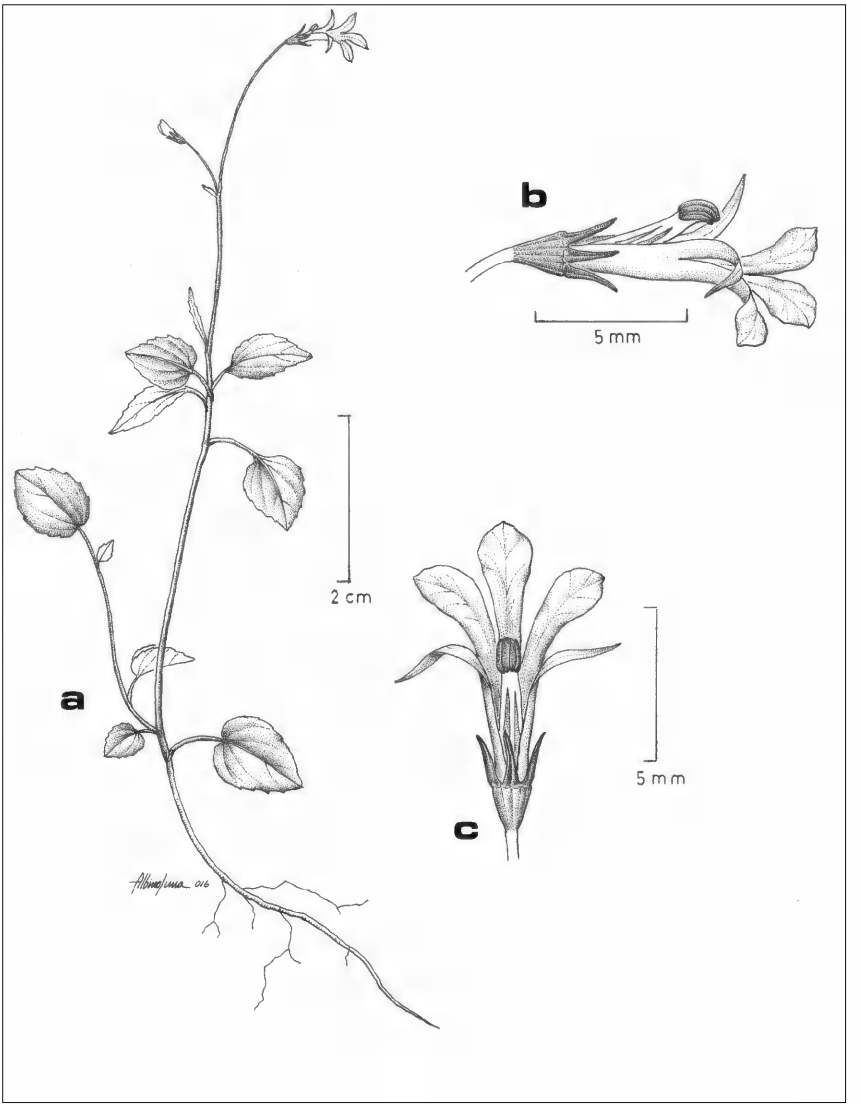

Figura 2. *Lobelia biflora.* A. Planta entera. B-C. Dos vistas de la flor. Ilustrado por Albino Luna.

Especie solo conocida de la colección original, al parecer restringida en su distribución a la parte alta del cerro de La Magdalena, bastante cercano a la ciudad de Xalapa.

El ejemplar *Carrillo-Reyes et al. 5440* fue inicialmente identificado de manera errónea como *Diastatea* aff. *virgata* y sus duplicados quedaron posiblemente así distribuidos a otros herbarios.

En su tamaño reducido y escaso número de flores, en las características de las hojas y de la corola, así como en la ubicación ecológica, *Lobelia biflora* se acerca a *L. schmitzii* E. Wimm. (=*Rapuntium pusillum* C. Presl), pero esta última difiere en ser planta anual, más robusta y compacta.

Lobelia schmitzii fue considerada por McVaugh (1943, p. 42) como sinónimo de *L. divaricata* Hook. & Arn., pero no pertenece allí, como ya lo indicaron Wimmer (1953, p. 500) y Morelos Ochoa (2001, p. 763). Su afinidad más cercana parece dirigirse hacia *L. seleriana* E. Wimm.

LOBELIA BIPINNATIFIDA Rzed., **sp. nov.** **TIPO: MÉXICO. Hidalgo**. Casetas, cerca de la desviación de Otongo; ca. 6.5 km al SW de Tlanchinol, municipio de Tlanchinol, bosque mesófilo en cañada, alt. 1475 m, abundante en taludes, 21.II.2003, *S. Zamudio* y *A. Ibarra 12312* (holotipo IEB, isotipos por distribuirse). Figura 3.

Planta annua gracilis ad 40(50) cm alta, ad basem pilosa; caules minus quam 1 mm diametro; folia parte majore rosulata, altera caulina, petiolata laminis 1-3 cm longis, 0.8-2 cm latis, profunde bipinnatisectis segmentis ultimis oblongis ad 4 mm longis et 1 mm latis: racemi laxi bracteis linearibus ad 1 cm longis, pedicellis ad 4 cm longis; hypanthium turbinatum ca. 1 mm longum, sepalis lanceolatis ca. 1 mm longis; corolla azurea tubo 2-3 mm longo profunde dissecto non fenestrato, labii superis segmentis lanceolatis 1.5-3 mm longis, labii inferis segmentis lateralibus oblongo-oblanceolatis 2-3.5 mm longis, segmento centrali spathulato; filamentorum tubus ca. 2 mm longus exsertus, antherae ca. 1 mm longae, inferae ad apicem barbatae; capsula ellipsoidea ca. 3 mm longa semiinfera; semina ellipsoidea 0.4-0.5 mm longa brunnea laevia nitida.

Planta anual hasta de 40(50) cm de alto, erecta, delicada, esbelta, pilosa en la base, glabra más arriba; tallos uno o varios partiendo de la base, simples o con más frecuencia ramificados, de menos de 1 mm de diámetro; hojas mayormente concentradas en roseta basal, otras pocas distribuidas a lo largo de los tallos, peciolos hasta de 2(5) cm de largo, láminas oblongas a ovadas en contorno general, de 1 a 3(5) cm de largo, de 0.8 a 2.5 cm de ancho, profundamente bipinnatífidas, con los últimos segmentos oblongos, hasta de 4(8) mm de largo y 1(2) mm de ancho; flores dispuestas en racimos muy laxos terminales, no o a veces solo parcialmente secundifloros, flores por racimo (2)3 a 10(14), brácteas lineares, hasta de 1 cm de largo, aunque por lo general mucho más cortas, pedicelos filiformes, lisos, de 1.5 a 4 cm de largo, ascendentes, bracteolas diminutas a veces presentes en la base; flores azules, moradas o blancas con morado; hipantio turbinado de ca. 1 mm de largo y de diámetro en la antesis, cáliz de 5 sépalos lanceolados, de ca. 1 mm de largo, de margen entero; corola glabra, tubo de 2 a 3 mm de largo, del lado dorsal hendido casi hasta la base, sin fenestración, segmentos del labio superior erectos, lanceolados, de 1.5 a 3 mm de largo, extendidos, los laterales del labio inferior oblongo-oblanceolados, de 2 a 3.5 mm de largo, el central espatulado, levemente más largo que los laterales; androceo exserto de la corola, tubo de los filamentos de ca. 2 mm de largo, glabro, anteras de ca. 1 mm de largo, las inferiores barbadas en el ápice, las superiores glabras; cápsula eliposoide, de ca. 3 mm de largo, semi-ínfera; semillas elipsoides, de 0.4 a 0.5 mm de largo, cafés, lisas, brillantes.

Material adicional examinado. **MÉXICO**. **Hidalgo**. Along Hwy 105 between Pachuca and Tampico, 96.8 mi N of Pachuca, 8.8 mi NNE of Lolotla, 14.2 mi N of Molango, 20°56' N 98°41' W, 1650 m; vegetation type: "selva baja subperennifolia," flowers white tinged lavender, 27.II.1987, *Croat & Hannon 65867* (ENCB); 2 km al N de Lolotla, sobre la carretera a Huejutla, vegetación de bosque mesófilo de *Liquidambar* y *Quercus*, alt. 1450 m, flores moradas, orilla de camino, 22.I.1972, *Rzedowski* y *Madrigal 29422* (ENCB).

La especie nueva se conoce de varias localidades próximas entre sí, por lo que debe ser un estrecho endemismo del sector meridional de la Sierra Madre Oriental. Aunque se registra como localmente abundante, al parecer restringe su hábitat a taludes y orillas de camino.

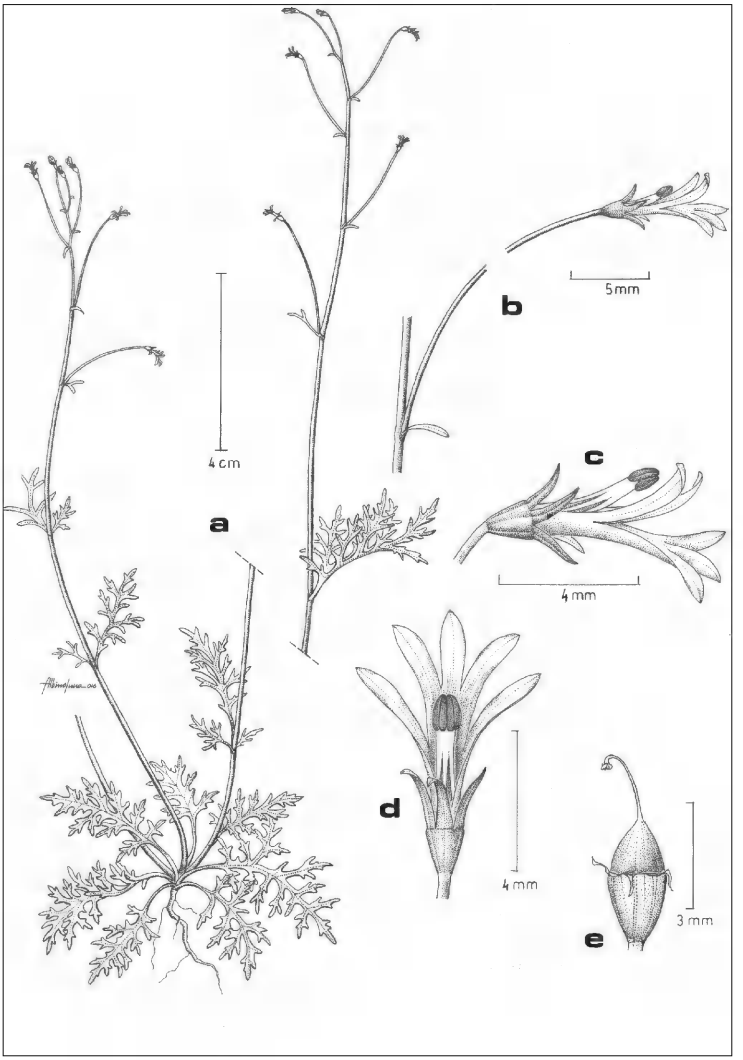

Figura 3. *Lobelia bipinnatifida*. A. Hábito de la planta. B. Pedicelo y flor. C-D. Dos vistas de la flor. E. fruto. Ilustrado por Albino Luna.

Lobelia bipinnatifida aparenta estar estrechamente relacionada con *L. subnuda* Benth., también conocida de Hidalgo, y con la cual concuerda en su hábito anual y grácil, pubescencia restringida a la parte basal de la planta, follaje concentrado en roseta basal, racimo laxo de pedicelos largos y ascendentes, flores pequeñas, hipantio turbinado y lóbulos del cáliz enteros.

Lobelia subnuda no tiene las hojas partidas y sus flores son ligeramente más grandes.

LOBELIA CORYMBIFORMIS Rzed., **sp. nov.** **TIPO: MÉXICO. Durango.** Potrero Labores de Milpillas, S.J. de Michis, municipio de Súchil, llano en bosque abierto de *Juniperus*, flor morada matizado, abundante, 27.I.1986, *J. Alvarado 736* (IEB). Figura 4.

Planta annua ad 10 cm alta; caules plerumque plures, simplices vel aliquot ramosi, erecti vel ascendentes, basaliter hispiduli, brunneo-rubelli; folia principalia rosulata plurima et dense imbricata, sessilia vel petiolata, laminis plerumque ellipticis alio modo oblanceolatis, ovatis vel subrotundis 5-15 mm longis, 2-7 mm latis, plerumque dentatis supra plerumque glabris, subtus plerumque hispidulis; inflorescentia corymbiformis fere laxa 2-6-flora, bracteis linearibus vel oblongis 2-5 mm longis, pedicellis filiformibus ad 2.8 cm longis; hypanthium turbinatum ca. 1 mm longum, brunneo-rubellum, glabrum, calycis lobuli oblongo-lanceolati ca. 2.5 mm longi, glabri; corolla purpurea mixta cum coloribus alliis, tubo ca. 4 mm longo, labii superis lobulis oblanceolatis ca. 2.5 mm longis, labii inferis lobulis late ovatis ca. 4 mm longis; tubus staminalis ca. 3 mm longus, antheris ca. 1.5 mm longis, minoribus apice barbatis; capsula ellipsoidalis, ca. 4 mm longa semiinfera; semina ellíptica compressa ca. 0.3 mm longa, pallide brunnea laevia nitida.

Planta anual hasta de 10 cm de alto, pequeña pero no delicada; tallos por lo general varios partiendo de la base de la planta, simples o algo ramificados, erectos o ascendentes, hispídulos con pelos de ca. 0.5 mm de largo en la porción proximal, glabros en la distal, café-rojizos; hojas principales agrupadas en roseta basal, numerosas, por lo general más de 15 y densamente imbricadas, sésiles o con peciolos hasta de 5 mm de largo, láminas mayormente elípticas, pero variando a oblanceoladas, ovadas o casi circulares, de 5 a 15 mm de largo, de 2 a 7 mm de ancho, agudas a redondeadas en el ápice, comúnmente cuneadas en la base, con 3 a 5 dientes en cada margen o algunas casi enteras, glabras o casi glabras en el haz, con frecuencia hispídulas en el envés, de textura membranácea, hojas caulinares 1 a 3, oblongas a lineares, de 3 a 10 mm de largo, agudas en el ápice; inflorescencias corimbiformes (los pedicelos de las flores inferiores se alargan con mucha rapidez alcanzando o sobrepasando el nivel de las flores más nuevas), por lo general moderadamente laxas, con 2 a 6 flores, brácteas lineares a oblongas, de 2 a 5 mm de largo, las inferiores algunas veces con el margen dentado, bracteolas ausentes, pedicelos filiformes, hasta de 2.8 cm de largo, glabros; hipantio turbinado, de ca. 1 mm de largo y ca. 1.5 mm de diámetro, café-rojizo, glabro, lóbulos del cáliz oblongo-lanceolados, de ca. 2.5 mm de largo, glabros, de margen entero; corola morada, matizada con otros colores, de ca. 8 mm de largo, tubo de ca. 4 mm de largo, hendido hasta cerca de la base, lóbulos del labio superior oblanceolados, de ca. 2.5 mm de largo y ca. 1 mm de ancho, los del labio inferior anchamente ovados, de ca. 4 mm de largo y ca. 2.5 mm de ancho: tubo estaminal de ca. 3 mm de largo, anteras de ca. 1.5 mm de largo, las inferiores barbadas en el ápice; cápsula elipsoide, de ca. 4 mm de largo, ínfera en aproximadamente la mitad de su largo: semillas elípticas, comprimidas, de ca. 0.3 mm de largo, cafés claras, lisas, brillantes.

Especie solo conocida de esta localidad, ubicada en las estribaciones orientales inferiores de la Sierra Madre Occidental.

En ser planta con las hojas numerosas y mayormente dispuestas en roseta basal, en desarrollar por lo general varios tallos a partir de la base, en la floración en época invernal, en las inflorescencias corimbosas, y en las flores de tamaño mediano, *Lobelia corymbiformis* se asemeja a *L. orientalis* Rzed. & Calderón, conocida de la Sierra Madre Oriental de Querétaro. Sin embargo, esta última discrepa, en ser planta perenne, en sus láminas foliares notablemente más anchas y todas evidentemente pecioladas, en el hipantio obsoleto, en las cápsulas totalmente súperas y ampliamente ovoides, en las semillas foveolado-reticuladas y en su hábitat más mesofítico.

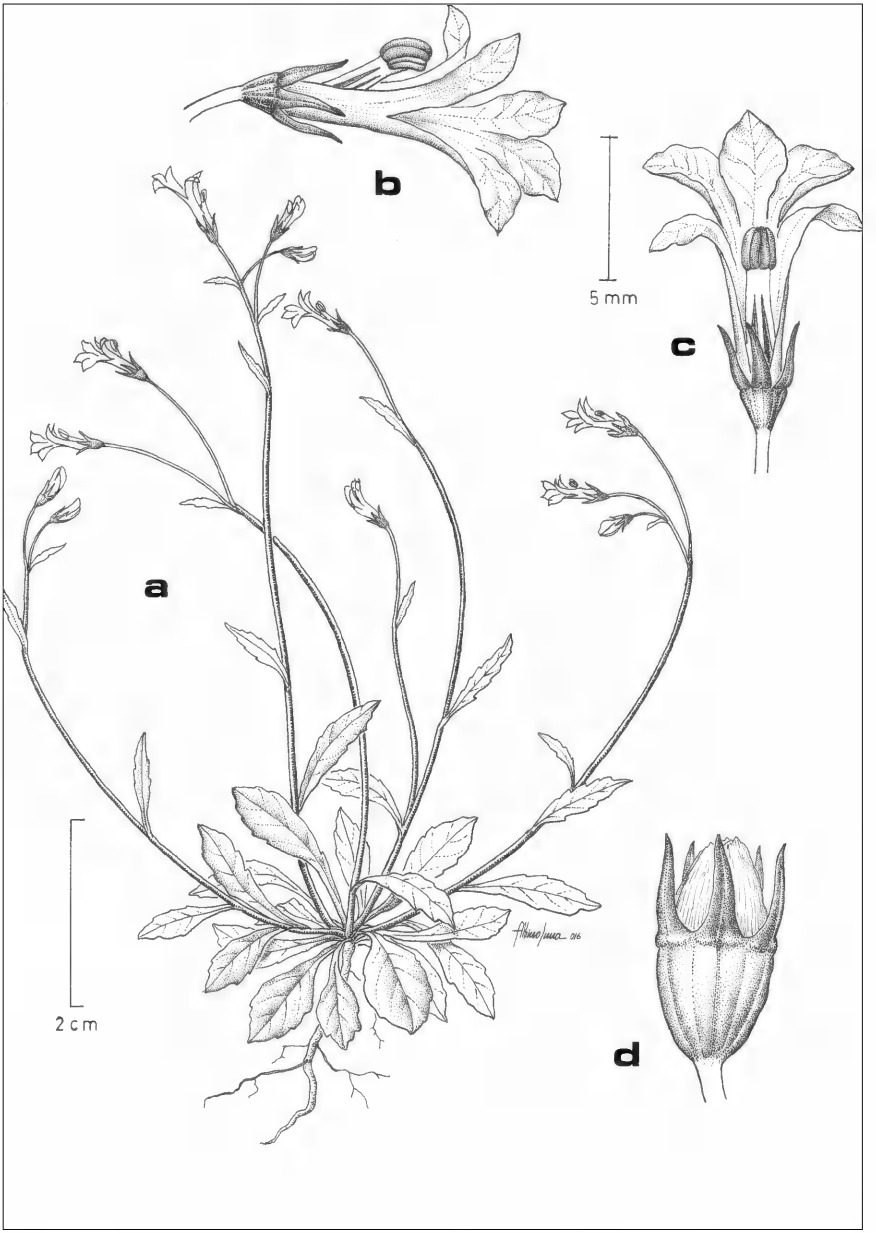

Figura 4. *Lobelia corymbiformis*. A. Planta entera. B-C. Dos vistas de la flor. D. Fruto. Ilustrado por Albino Luna.

LOBELIA DIVERGENS Rzed., **sp. nov**. **TIPO: MÉXICO. Guerrero.** Municipio de General Heliodoro Castillo, a 1.5 km al N de Agua Fría, 17°27'26'' N, 100°03'56'' W, bosque de *Pinus-Abies*, alt. 2600 m, arbusto de 1 m de alto, abundante, 13.XII.1987, *A. Aquino Carreño 229* (IEB). Figura 5.

Planta herbacea perennis usque 1 m alta; caules erecti ramosi glabri; folia sessilia vel fere sessilia plerumque elliptica 1.5-5 cm longa, 3-15 mm lata, apice acuta, base longe attenuata, margine dentata vel denticulata, supra glabra vel fere glabra, infra hispidula; racemi laxi non secundiflori 10-16 cm longi bracteis 6-14 mm longis et pedicellis (1)1.5-3 cm longis glabris; hypanthium minutum, calycis segmenti subulati 2.5-3 mm longi plerumque divaricati margine integri; corolla alba tubo non fenestrato 3-3.5 mm longo, labii superis segmentis subulatis ca. 2 mm longis, labii inferis segmentis obovatis, ca. 3 mm longis; filamentorum tubus ca. 3 mm longus, antherae ca. 1 mm longae, tres superae fuscae fertiles, duo inferae albae et ut videtur steriles; capsula ellipsoidea infera in 1/3-3/5 altitudinis, ca. 8 mm longa; semina ellipsoidea ca. 0.8 mm longa brunnea laevia nítida.

Planta herbácea perenne hasta de 1 m de alto; raíces largas, delgadas; tallos varios partiendo de la base, erectos, ramificados, glabros; hojas sésiles o casi sésiles, mayormente elípticas, algunas de las inferiores casi circulares, las superiores prácticamente lineares, de 1.5 a 5 cm de largo, de 3 a 15 mm de ancho, agudas en el ápice, largamente atenuadas hacia una corta base pecioliforme, dentadas a denticuladas en el margen, glabras o casi glabras en el haz, hispídulas a lo largo de las nervaduras en el envés, de textura membranácea; inflorescencias en forma de racimos terminales laxos no secundifloros de 10 a 16 cm de largo con ca. 15 flores, brácteas angostamente lineares, de 6 a 14 mm de largo, disminuyendo paulatinamente de tamaño hacia el ápice del racimo, pedicelos filiformes, de (1)1.5 a 3 cm de largo, ascendentes y encorvados en su extremo distal, glabros; hipantio turbinado, pequeño, lóbulos del cáliz subulados, de 2.5 a 3 mm de largo, de margen entero, mayormente divergentes desde la antesis; corola blanca, su tubo de 3 a 3.5 mm de largo, hendido en poco menos de la mitad de su largo, lóbulos del labio superior subulados, de ca. 2 mm de largo, los del labio inferior oblanceolados, de ca. 3 mm de largo; tubo estaminal de ca. 3 mm de largo, anteras de ca. 1 mm de largo, las tres superiores de color oscuro y glabras, las dos inferiores barbadas en el ápice, pero de color blanco y aparentemente estériles; cápsula elipsoide, de 6 a 7 mm de largo, ínfera en 1/3 a 3/5 de su longitud; semillas elipsoides, de ca. 0.8 mm de largo, cafés, lisas, brillantes.

Especie solo conocida de la colecta original, de donde se registra como abundante. Sin embargo, se trata muy probablemente de un estrecho endemismo de un corto sector de la Sierra Madre del Sur de Guerrero.

En su carácter de planta herbácea perenne con hojas mayormente elípticas y largamente atenuadas hacia una base pecioliforme, en su hipantio diminuto y segmentos del cáliz subulados, así como en la flor de tamaño mediano *Lobelia divergens* debe estar relacionada con *L. diastateoides* McVaugh, planta conocida también de Guerrero, al igual que de Oaxaca y de Chiapas. Las principales diferencias entre las dos especies se enlistan en el Cuadro 1.

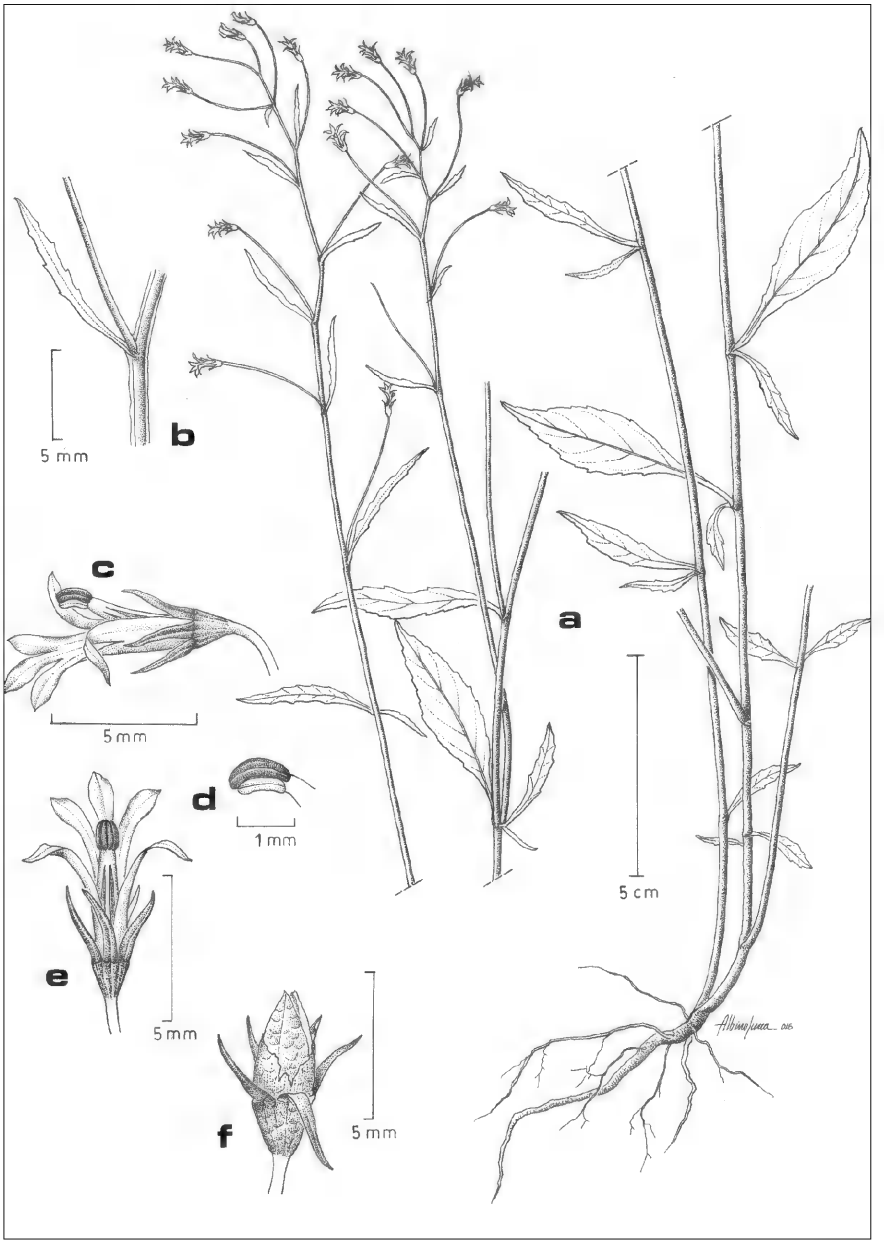

Figura 5. *Lobelia divergens*. A. Hábito de la planta. B. Base de un pedicelo. C. y E. Dos vistas de la flor. D. Antera. F. Fruto. Ilustrado por Albino Luna.

	Lobelia diastateoides	Loblia divergens
Altura de la planta	20 a 45 cm	hasta 1 m
Pubescencia del tallo	hispídulo en la parte inferior	glabro
Pubescencia de las hojas	hispídulas en ambas superficies	glabras o casi glabras en el haz, hispídulas a lo largo de las nervaduras en el envés
Segmentos del cáliz	mayormente erectos	mayormente divergentes
Corola		
color	azul o violeta	blanco
tubo (largo)	4 a 4.5 mm	3 a 3.5 mm
segmentos del labio superior	elípticos, de ca. 4 mm de largo	subulados, de ca. 2 mm de largo
segmentos del labio inferior	oblongos, de ca. 3.5 mm de largo	oblanceolados, de ca. 3 mm de largo
Anteras	las 5 fértiles	las 3 mayores fértiles, las 2 menores aparentemente estériles
Cápsula		
largo	ca. 6 mm	ca. 8 mm
ubicación	súpera o ínfera en menos de 1/3 de su largo	ínfera en 1/3 a 3/5 de su largo
Semilla (largo)	ca. 0.6 mm	ca. 0.8 mm

Cuadro 1. Principales diferencias entre *Lobelia diastateoides* y *L. divergens*.

LOBELIA GUZMANII Rzed., **sp. nov. TIPO: MÉXICO. Durango.** Puente El Cajón de San Antonio a 10 km de Altares, camino Santiago-Cuevecillas, vegetación riparia de *Pinus, Quercus* y *Pseudotsuga*, alt. 1510 m, herbácea erguida de 25 cm de altura, flor violeta, abundante, 2.X.1990, *Oscar Bravo Bolaños 1698* (IEB). Figura 6.

Planta herbacea ut videtur perennis ad 40 cm alta glabra; caules erecti brunnei superne ramosi; folia caulina, anguste linearia (1)2.5-6 cm longa, (0.2)0.6.1.5(2) mm lata margine denticulata; racemi terminales longe pedunculati breves 1-3-flori, racemi omnes in catervam paniculiformem dispositi, pedicellis ca. 10 mm longis ad basem bibracteloatis; hypanthium turbinatum, calycis segmenti anguste triangulares ca. 4 mm longi; corolla violacea tubo ca. 4 mm longo non fenestrato, labii superis lobulis anguste triangularibus ca. 4 mm longis, labii inferis lobulis oblanceolatis ca. 5 mm longis; filamentorum tubus ca. 3 mm longus, antherae ca. 2 mm longae, inferae apice barbatae; capsula ellipsoidalis ca. 7 mm longa semiinfera; semina elliptica compressa ca. 0.3 mm longa atrobrunnea laevia nitida.

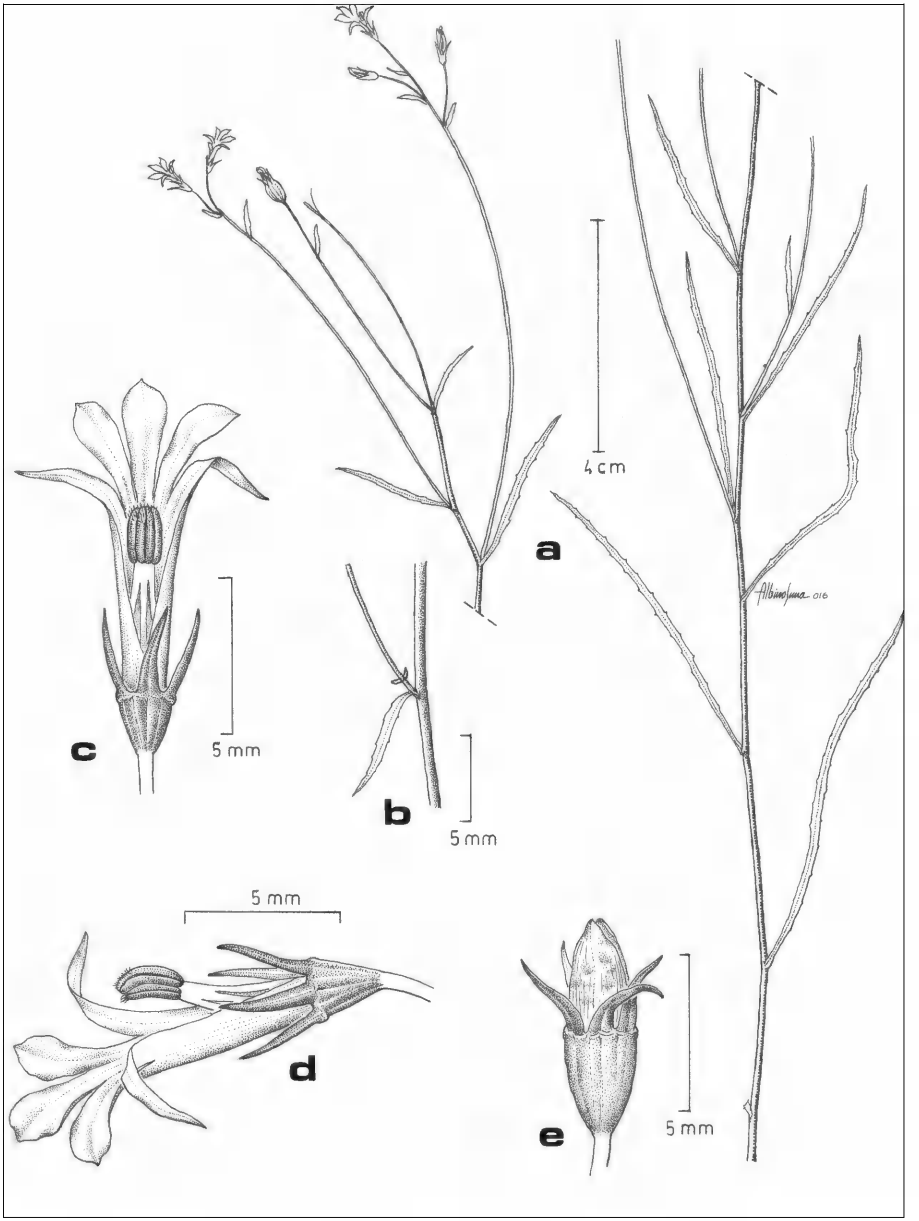

Figura 6. *Lobelia guzmanii*. A. Hábito de la planta. B. Base del pedicelo y bracteolas. C-D. Dos vistas de la flor. E. Fruto. Ilustrado por Albino Luna

Planta herbácea al parecer perenne, hasta de 40 cm de alto, glabra; tallos erectos, de ca. 1 mm de diámetro, cafés, ramificados en su mitad distal; hojas todas caulinas, sésiles, angostamente lineares, de (1)2.5 a 6 cm de largo, de (0.2)0.6 a 1.5(2) mm de ancho, largamente atenuadas en el ápice, irregular y esparcidamente denticuladas en el margen; inflorescencias en forma de racimos terminales largamente pedunculados, cortos y más bien compactos, de 1 o 3 flores, el conjunto de los racimos se dispone a manera de una especie de panícula corimbiforme, brácteas lineares, de 3 a 4 mm de largo, pedicelos filiformes, de ca. 10 mm de largo, con un par de bracteolas diminutas en la base; hapantio turbinado, de 1.5 a 3 mm de largo, de ca. 1 mm de diámetro, segmentos del cáliz angostamente triangulares, de ca. 4 mm de largo, de margen entero; corola de color violeta, tubo de ca. 4 mm de largo, hendido casi hasta la base, sin aperturas adicionales, lóbulos del labio superior angostamente triangulares, de ca. 3 mm de largo, los del labio inferior oblanceolados, de ca. 5 mm de largo; tubo estaminal de ca. 3 mm de largo, anteras de ca. 2 mm de largo, las inferiores barbadas en el ápice; cápsula elipsoide, de ca. 7 mm de largo, semi-ínfera: semillas elípticas, comprimidas, de ca. 0.3 mm de longitud, cafés oscuras, lisas, brillantes.

Planta solo conocida de la localidad mencionada, ubicada en la Sierra Madre Occidental.

Lobelia guzmanii aparenta estar relacionada con *L. gruina* Cav. en virtud de sus racimos breves con pedicelos relativamente cortos y provistos de bracteolas en la base, hojas angostas, flores de tamaño mediano y hábito al parecer perenne. Sin embargo, la especie nueva se distingue en ser planta totalmente glabra, con las hojas aun más estrechas, con inflorescencias agrupadas en especie de panícula corimbiforme, con menor número de flores y éstas más pequeñas.

El epíteto se dedica a la memoria del recientemente desaparecido Gastón Guzmán Huerta (1932-2016), destacado pionero e impulsor del estudio de los hongos, tanto en México como en varios otros países. Guzmán fue un micólogo de altos vuelos y contribuyó en buena parte al reconocimiento internacional de las instituciones en que laboró. Fue nombrado investigador emérito del Instituto de Ecología, A.C.

LOBELIA OAXACANA Rzed., **sp. nov.** **TIPO: MÉXICO. Oaxaca.** 7 km al SO-S de Suchixtlahuaca, por terracería rumbo a Santiago Tejupan, 17°41' N, 97°25' O, bosque de *Quercus* y *Juniperus*, 20.XI.1985, *A. Salinas T.* y *O. Dorado R. F-3037* (ENCB). Figura 7.

Planta herbacea perennis ad 20 cm alta; caules numerosi erecti vel ascendentes minus quam 1 mm diametro; folia ad plantae basem concentrata sessilia elliptica 6-9 mm longa, 1.5-2.5 mm lata, ad apicem acuta, ad basem cuneata; racemi laxi non secundiflori 4-7 cm longi, 4-9 floribus, pedicellis filiformibus 4-18 mm longis; hypanthium minutum, calycis segmenti lineares 1-1.5(2) mm longi; corolla purpurea tubo multo plus fusco quam lobos 4.5-5.5 mm longo, fissura dorsali ca. 1 mm profunda, labii superis lobis linearibus ca 2 mm longis, labii inferis lobis ellipticis vel ovatis ca 3 mm longis; filamentorum tubus quam corollae tubum longior, antherae manifeste exsertae ca. 1.5 mm longae, longiores pubescentes, breviores ad apicem barbatae; capsula supera anguste ellipsoidea ca. 6 mm longa; semina brunnea ca. 0.2 mm longa.

Planta herbácea perenne hasta de 20 cm de alto; raíz axonomorfa hasta de ca. 10 cm de largo; tallos numerosos (ca. 20) partiendo de la base de la planta, los centrales erectos, los laterales ascendentes, de menos de 1 mm de diámetro, sin ramificarse, hispídulos en la porción proximal con pelos de ca. 0.1 mm de largo; hojas concentradas en los 3.5 cm basales de la planta, sésiles, elípticas, de 6 a 9 mm de largo, de 1.5 a 2.5 mm de ancho, agudas en el ápice, cuneadas en la base, denticuladas en el margen, hispídulas a glabrescentes en ambas superficies; inflorescencias en forma de racimos laxos, no secundifloros, de 4 a 7 cm de largo, en su mayoría largamente pedunculados, con 4 a 9 flores, brácteas lineares, las inferiores hasta de 1 cm de largo, las superiores de 1.5 a 3 mm de largo, pedicelos filiformes, de 4 a 18 mm de largo, ascendentes y algo arqueados en la parte distal, glabros, bracteolas ausentes; hipantio diminuto, a menudo casi obsoleto, segmentos del cáliz lineares, de 1 a

1.5(2) mm de largo; corola morada, el tubo mucho más oscuro que los lóbulos, tubo de 4.5 a 5 mm de largo, con hendidura dorsal de ca. 1 mm de profundidad, sin aperturas adicionales, lóbulos del labio superior lineares, de ca. 2 mm de largo, los del labio inferior elípticos a ovados, de ca. 3 mm de largo; tubo estaminal un poco más largo que el de la corola, por lo que las anteras se observan manifiestamente exsertas, su tubo de ca. 1.5 mm de largo, las más largas pubescentes en el dorso, las más cortas barbadas en el ápice; cápsula súpera, angostamente elipsoide, de ca. 6 mm de largo, a menudo lustrosa; semillas angostamente elipsoides, de ca. 0.2 mm de largo, cafés, lisas.

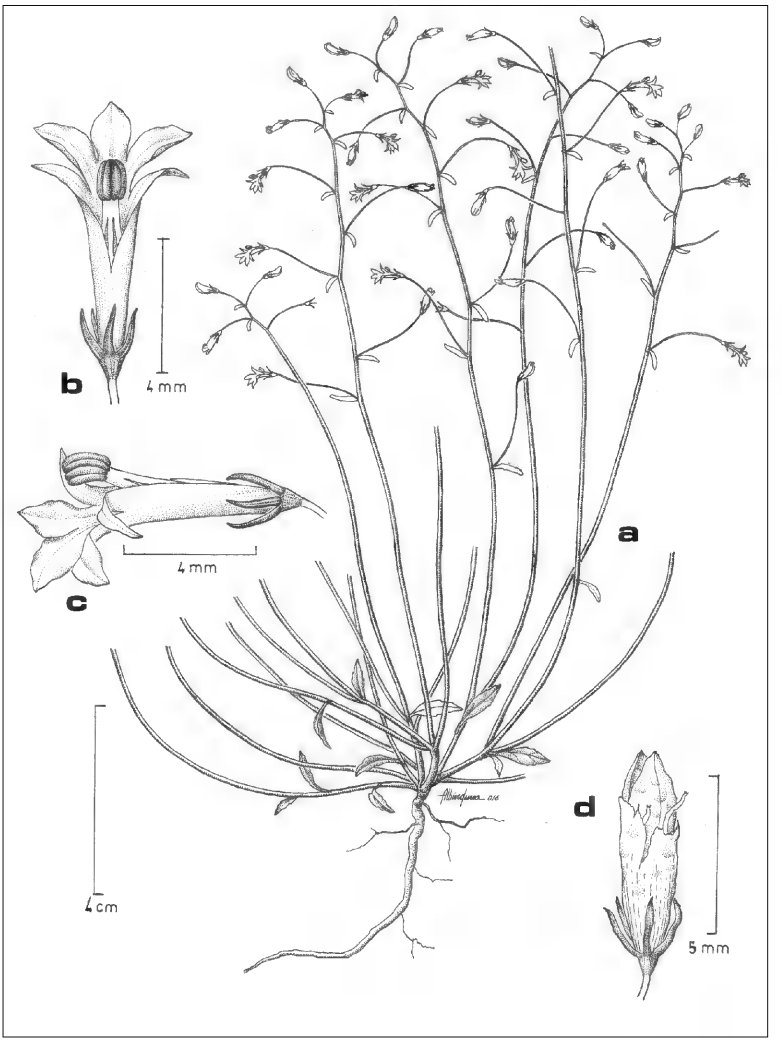

Figura 7. *Lobelia oaxacana*. A. Hábito de la planta. B-C. Dos vistas de la flor. D. Fruto. Ilustrado por Albino Luna.

Especie solo conocida de la localidad tipo ubicada en el distrito de Coixtlahuaca, región de Mixteca Alta, en el norte de Oaxaca.

En ser planta perenne, con flores de ca. 8 mm de largo, corola con el tubo apenas hendido, las anteras más largas pubescentes y cápsula súpera, *Lobelia oaxacana* se relaciona con *L. diastateoides* McVaugh, especie también conocida de Oaxaca, además de Chiapas y Guerrero. Las diferencias entre ambas se resumen en el Cuadro 2 y aunque casi todas son de índole cuantitativa, en realidad las respectivas plantas son fisonómicamente muy distintas entre sí.

	Lobelia diastateoides	**Lobelia oaxacana**
Tallos	por lo general solitarios	numerosos partiendo de de la base de la planta
Hojas, tamaño en cm	1.4–3(7) x 0.6-1.1(2)	0.6–0.9 x 0.15–0.25
Segmentos del cáliz, largo en mm	2.5–3.5	1–1.5(2)
Corola		
coloración	más o menos uniforme	tubo mucho más oscuro que los lóbulos
largo de la hendidura dorsal del tubo en mm	2.5–2.8	ca. 1
Cápsula, largo en mm	4.5–5.5	ca. 6
Semilla, largo en mm	ca. 0.6	ca. 0.2

Cuadro 2. Principales diferencias entre *Lobelia oaxacana* y *L. diastateoides.*

Por otro lado es interesante enfatizar que, en función de su cápsula súpera y tubo corolino apenas hendido, *Lobelia oaxacana* quizás represente una posición algo intermedia entre los géneros *Lobelia* y *Diastatea.*

Lobelia oaxacana difiere de las especies conocidas de *Diastatea* en ser planta perenne, con flores de tubo corolino algo hendido en el dorso y de labio inferior no claramente pediculado ni independizado, en tener las anteras manifiestamente exsertas y las más grandes provistas de pubescencia en su superficie abaxial.

LOBELIA SUBSCAPOSA Rzed., **sp. nov. TIPO: MÉXICO. Oaxaca.** Cerro Pelón, municipio de Comaltepec, distrito de Ixtlán, bosque de *Quercus*, alt. 2850 m, 26.II.1972, *J. Rzedowski 28868* (ENCB). Figura 8.

Planta herbacea perennis ad 11 cm alta subscapiformis; caulis unicus non ramosus; folia principalia rosulata petiolata elliptica 4-11 mm longa, apice acuto ad rotundato, base cuneata, margine fere integra vel denticulato-crenata glandulas rubellas ad denticulorum apices ferentia, crassa et coriacea, folia caulina 0-5 linearia minus quam 1 mm lata; inflorescentia corymbiformis ca. 4-flora, bracteis 2-4 mm longis, pedicellis filiformibus ascendentibus 1-1.6 cm longis; hypanthium turbinatum ca. 1 mm longum, calycis segmentis linearibus ca. 3 mm longis; corolla azureo-purpurea tubo ca. 3.5 mm longo profunde

fissurato non fenestrato, labii superis segmentis linearibus ca. 3 mm longis, labii inferis segmentis spathulatis ca. 5 mm longis; filamentorum tubus ca. 3 mm longus, antherae ca. 1.8 mm longae puberulae; capsula inmatura semiinfera ellipsoidea ca. 4 mm longa; semina ignota.

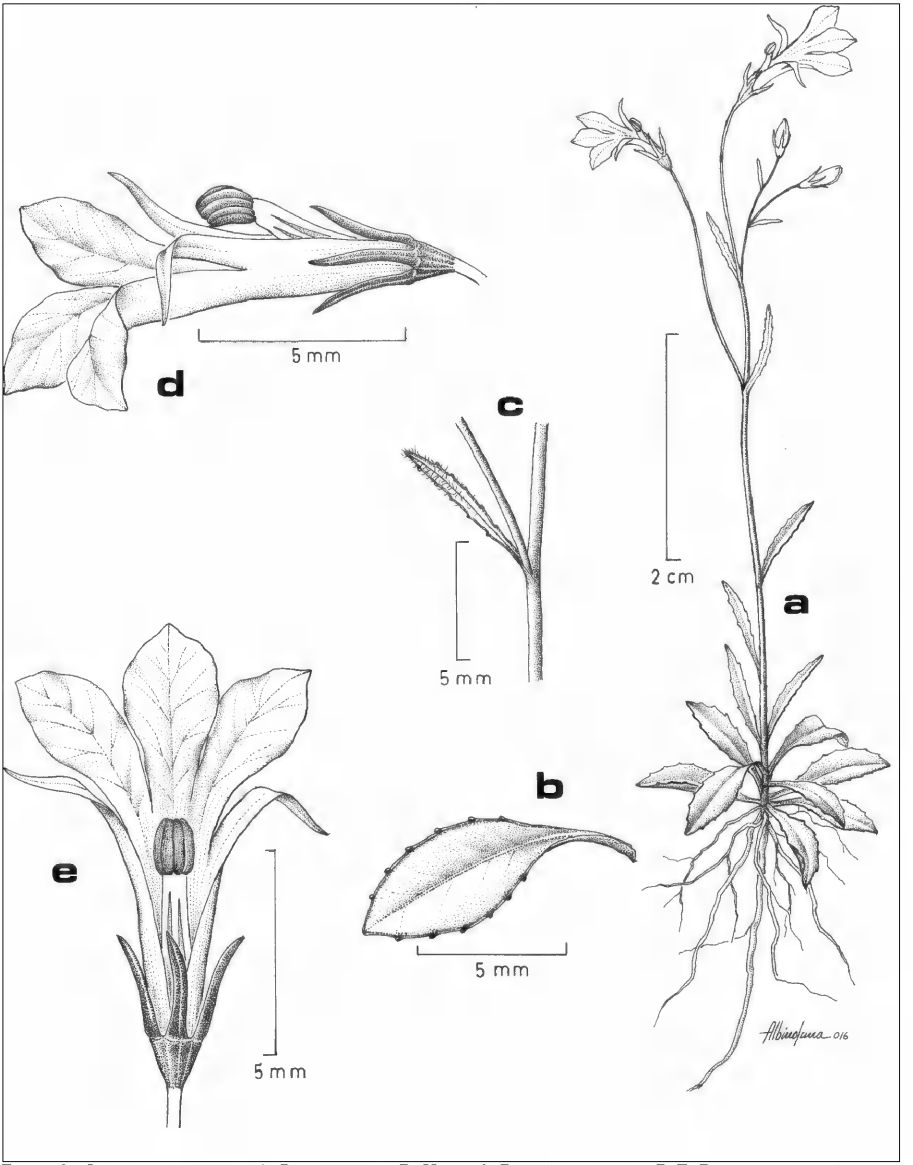

Figura 8. *Lobelia subscaposa.* A. Planta entera. B. Hoja. C. Base del pedicelo. D-E. Dos vistas de la flor. Ilustrado por Albino Luna.

Planta herbácea perenne hasta de 11 cm de alto, casi escapiforme; raíces por lo general varias; tallo solitario, erecto, sin ramificarse, hispídulo con pelos ca. 0.1 mm de largo en la base, glabro más arriba; hojas principales dispuestas en roseta basal, peciolos hasta de 5 mm de largo, láminas elípticas, de 4 a 11 mm de largo, de 1.5 a 5.5 mm de ancho, agudas a redondeadas en el ápice, cuneadas en la base, casi enteras a someramente denticulado-crenadas en el margen y provistas de notables glándulas rojizas, glabras o casi glabras, gruesas y de textura coriácea, las hojas caulinares 0 a 5, lineares, de 2.5 a 9 mm de largo, de menos de 1 mm de ancho, a menudo blanquecinas en el envés, con textura y glándulas similares a las de las hojas basales; inflorescencia en forma de racimo corimbiforme, pues los pedicelos pronto exceden en largo al eje principal, de ca. 4 flores, brácteas similares a las hojas caulinares, pero de 2 a 4 mm de largo, pedicelos filiformes, ascendentes, de 1 a 1.6 cm de largo, glabros, bracteolas ausentes; hipantio turbinado, de ca. 1 mm de largo y de diámetro, segmentos del cáliz lineares, de ca. 3 mm de largo, de margen entero, erectos; corola azul-morada, tubo de ca. 3.5 mm de largo, hendido casi hasta cerca de la base, sin aperturas adicionales, segmentos del labio superior lineares, de ca. 3 mm de largo, los del labio inferior espatulados, de ca. 5 mm de largo, mucronados en el ápice; tubo de los filamentos de ca. 3 mm de largo, tubo de las anteras de ca. 1.8 mm de largo, éstas finamente pubérulas con pelos cafés; cápsula inmatura elipsoide, semi-ínfera, de ca. 4 mm de largo; semillas desconocidas.

Especie solo conocida de la localidad tipo, ubicada en la Sierra Norte de Oaxaca, en el sector conocido como Sierra de Juárez.

En ser planta perenne, pequeña, casi escapiforme, con tallo solitario, inflorescencia de pocas flores y hojas coriáceas, *Lobelia subscaposa* no encuentra claro parentesco con otras especies mexicanas del género. Las anteras pubérulas, unidas a la carencia de barbas en el extremo distal de las inferores, ponen inclusive en duda su correcta ubicación en la sección *Stenotium.*

Fisonómicamente se asemeja a algunas poblaciones de *Lobelia seleriana* E. Wimm., planta conocida del centro del país, pero esta última es anual, habitante de suelos permanentemente húmedos y carece de hojas gruesas.

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THE CURIOUS DISTRIBUTION OF *ASCLEPIAS TOMENTOSA* (APOCYNACEAE)

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ABSTRACT

Herbarium and literature research confirms that the distribution of *Asclepias tomentosa* exhibits two gaps, one between the Carolinas and Florida, the second between Florida and Texas. This particular distribution pattern is unusual among coastal plain vascular plant taxa.

Asclepias tomentosa Ell. (Figure 1) was described "From specimens collected, I believe, by Dr. Baldwin near St. Mary's, Georgia" (Elliott 1817). St. Mary's is a port town in Camden County. This species inhabits xeric, acidic, sandy soils of sandhills, sand barrens, inland dunes, and ridges, often accompanied by shrub oaks, small tree oaks, and pines. In addition, it has been recorded from powerlines and roadsides. The distribution is most often given as North Carolina to Florida to Texas, but Woodson (1954) described it as "North Carolina to Florida; eastern Texas." Note Woodson's use of a semicolon; it implies a gap in distribution. This suggestion, coupled with my failure to encounter *A. tomentosa* while performing field surveys in the coastal plain of Georgia, Alabama, Mississippi, and Louisiana in the 1990s, led me to reassess the distribution of the species.

Figure 1. *Asclepias tomentosa.* Hoke Co., North Carolina. Photo by B.A. Sorrie.

Figure 2 displays the county distribution of *Asclepias tomentosa*, derived from verified specimens, cited specimens in journals, and floristic atlases. This map is closely similar to that of BONAP (2014) and corroborates the gap apparently suggested by Woodson's citation. State-by-state distribution from east to west is summarized following the map.

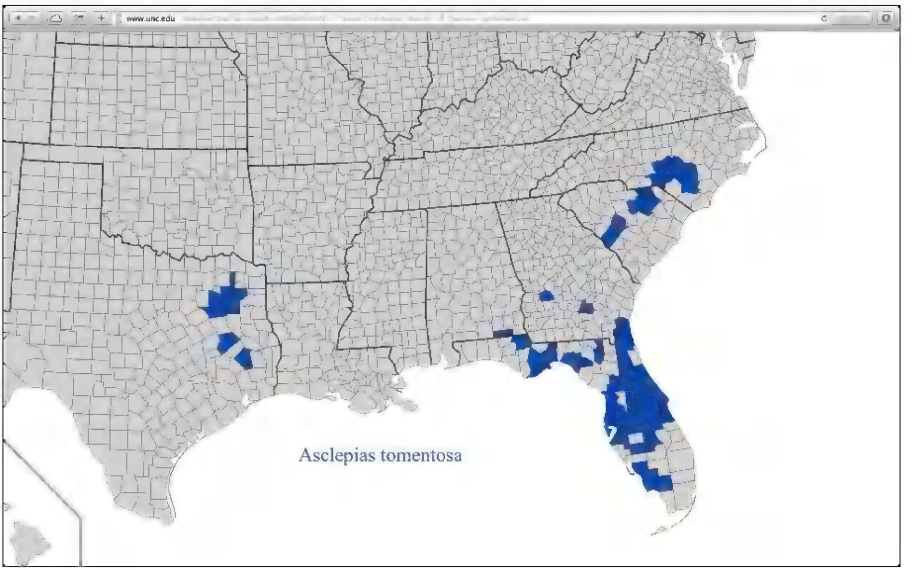

Figure 2. County distribution of *Asclepias tomentosa*.

North Carolina. Nine counties, seven of them within the Sandhills Physiographic Province and two on the middle Coastal Plain.

South Carolina. Six counties, all within the Sandhills Physiographic Province. Aiken Co. is newly reported here: *Ravenel s.n.* (GH).

Georgia. Three counties: Camden (cited by Elliott 1817), Coffee (Norris 1319, VSC), and Sumter (BONAP 2014). The extreme rarity of *A. tomentosa* in Georgia creates a gap in distribution between the Carolinas and Florida, a phytogeographic pattern previously discussed by Sorrie et al. (1997). A number of such plants are disjunct from the Gulf Coastal Plain to the Sandhills of the Carolinas [e.g., *Rhynchospora macra* (C.B. Clarke) Small and *Xyris scabrifolia* Harper]; others are disjunct to the Outer Coastal Plain from a distribution that centers on peninsular Florida [e.g., *Rhynchospora galeana* Naczi, W. Knapp, & G. Moore and *Crocanthemum nashii* (Britt.) Barnhart].

Florida. This state clearly is the center of the species' distribution in terms of numbers of county occurrences. Wunderlin and Hansen (2011) described it as "occasional." Clewell (1985) reported it also from Jackson Co.

Alabama. There is no record in Mohr (1901), BONAP (2014), or the Alabama Plant Atlas (2016). Here I report a collection from Geneva Co.: *Kral 32543* (FSU).

Mississippi. There is no record in Lowe (1921), BONAP (2014), or in specimen searches at MISS, MISSA, and USMS. A recent survey of a large sandhill ecosystem in Wayne Co. (McNair et al. 2016) did not locate any *A. tomentosa*.

Louisiana. There is no record in Thomas and Allen (1996), BONAP (2014), or in specimen searches at LSU and NLU.

Texas. Turner et al. (2003) mapped it in six counties in east Texas in Post Oak Savannah and Pineywoods vegetational regions. In addition, specimens have been collected in Smith Co. (*Reverchon s.n.*, MO) and Upshur Co. (*Shinners 30278*, BRIT) in these same vegetational regions.

Double disjunction

The double disjunction shown by *Asclepias tomentosa* is very unusual, perhaps unique, and is not matched by other species of the coastal plain. The distance between Aiken Co., South Carolina and Coffee Co., Georgia is 270 km and between Geneva Co., Alabama and Polk Co., Texas is 860 km. The recently described orchid *Spiranthes sylvatica* P.M. Brown (Brown 2001) comes close to duplicating the distribution of *A. tomentosa*, occurring in southeastern Virginia to northeastern South Carolina, southwestern Georgia to central Florida, and central Louisiana to southeastern Texas. The apparently sporadic distribution of *S. sylvatica*, however, may reflect an incomplete knowledge of a "new" species. Several other species show a single disjunction across Alabama, Mississippi, and eastern Louisiana; e.g., *Lyonia mariana* (L.) D. Don, *Litsea aestivalis* (L.) Fern., and *Spartina bakeri* Merr. *Berlandiera pumila* (Michx.) Nutt. also is similar in distribution to *A. tomentosa*, but with a smaller gap through Georgia, more records in Alabama, and occurrences in western Louisiana.

One might ask whether the disjunctions shown by *Asclepias tomentosa* are artifacts of a scarcity of xeric habitats in Alabama, Georgia, Louisiana, and Mississippi, or of collecting. I think not. First, many other xerophiles occur in these gap states, as evidenced by online and published plant atlases. In addition, MacRoberts et al. (2002) discussed the occurrences of endemic taxa of xeric soils of the West Gulf Coastal Plain. These xerophiles are well distributed within the physiographic regions of these states where one would expect *A. tomentosa* to occur. Second, dozens of botanists have collected thousands of specimens over the past 150 years in these states while yielding very few collections of *A. tomentosa*. It appears that the gaps in distribution are real, but understanding the cause remains a challenge. It seems likely to relate to a past fragmentation of suitable habitats, leading to the extirpation of *A. tomentosa* in intervening areas and its failure to recolonize those areas.

Rarity

State ranks of *Asclepias tomentosa* from NatureServe (2016) are these: Alabama (State Not Ranked), Florida (State Not Ranked), Georgia (State Unrankable), North Carolina (S3), South Carolina (State Not Ranked), and Texas (S3). It is likely that Alabama and Georgia left *A. tomentosa* unranked due to a paucity of records. I here suggest updated ranks for each state of occurrence: Alabama-SH, Florida-S4, Georgia-SH, North Carolina-S3, South Carolina-S2, and Texas-S3.

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Schoenig, S. 2016. Rediscovery of *Erythranthe percaulis* (Phrymaceae) in the Feather River Canyon. Phytoneuron 2016-69: 1–14. Published 7 November 2016. ISSN 2153 733X

REDISCOVERY OF *ERYTHRANTHE PERCAULIS* (PHRYMACEAE) IN THE FEATHER RIVER CANYON

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ABSTRACT

The probable type locality of *Erythranthe percaulis* has been relocated in the Feather River Canyon (Serpentine Canyon, East Branch of North Fork of Feather River) in Plumas Co., California, confirming the existence of this distinctive species. The species was recently described from a single collection made in 1980 and until now has been known only from the type. Plants are abundant at the locality documented here, which is on the serpentine slopes on the north side of Highway 70 passing through Serpentine Canyon. Color photos illustrate the habitat and habit of the plants.

An attempt to relocate the type locality of the recently described *Erythranthe percaulis* Nesom (2013) was successful. It was originally collected in May 1980 in Serpentine Canyon (East Branch of North Fork of Feather River, Plumas County) by J.T. Howell. David Popp and I found it still there in abundance on 24 May 2016. The population is large but the species remains known only from the general locality.

The plants occur along about 1.0 mile between 40° 01'18.62"N / 121° 09'50.45'W and 40° 01'33.94"N / 121° 08'27.16"W. From the town of Belden the plants begin at 6.2 miles east on Hwy 70 and end at 7.2 miles. Corresponding mileage from county road signs are marked 21.80 to 20.74 to from west to east. In this area, the plants grow between 780-855 meters elevation in crevices, among boulders, and in soil pockets on wet serpentine cliffs and slopes and at the base of the westbound roadcut. These steep cliffs on the north side of the road are serpentine and the species apparently is restricted to that substrate. The extended population contains many thousands of individuals. Climbing above the manufactured steep roadcut onto the natural slope was not feasible, so it is unclear if the population extends to higher elevations.

A voucher was not collected but the habitat and population are documented by many photos. Representative morphology of *Erythranthe percaulis* is shown in Figures 1–14.

In our observations, *Erythranthe percaulis* is relatively uniform in morphology. There was no indication of gene exchange with other *Erythranthe* species in the immediate area. Clusters of *E. microphylla* (Figs. 15, 16) are scattered through the larger *E. percaulis* population. A variant of *E. moschata* (under study by Nesom) occurs at this site as well as others in the Serpentine Canyon area.

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Figure 1. Habitat of *Erythranthe percaulis* at the probable type locality –– Serpentine Canyon, East Branch of North Fork of Feather River. Top: Main population segment. Bottom: Plants occurred on the steep road cut and in the drainage channel next to the road. Botanist David Popp is shown in both photos.

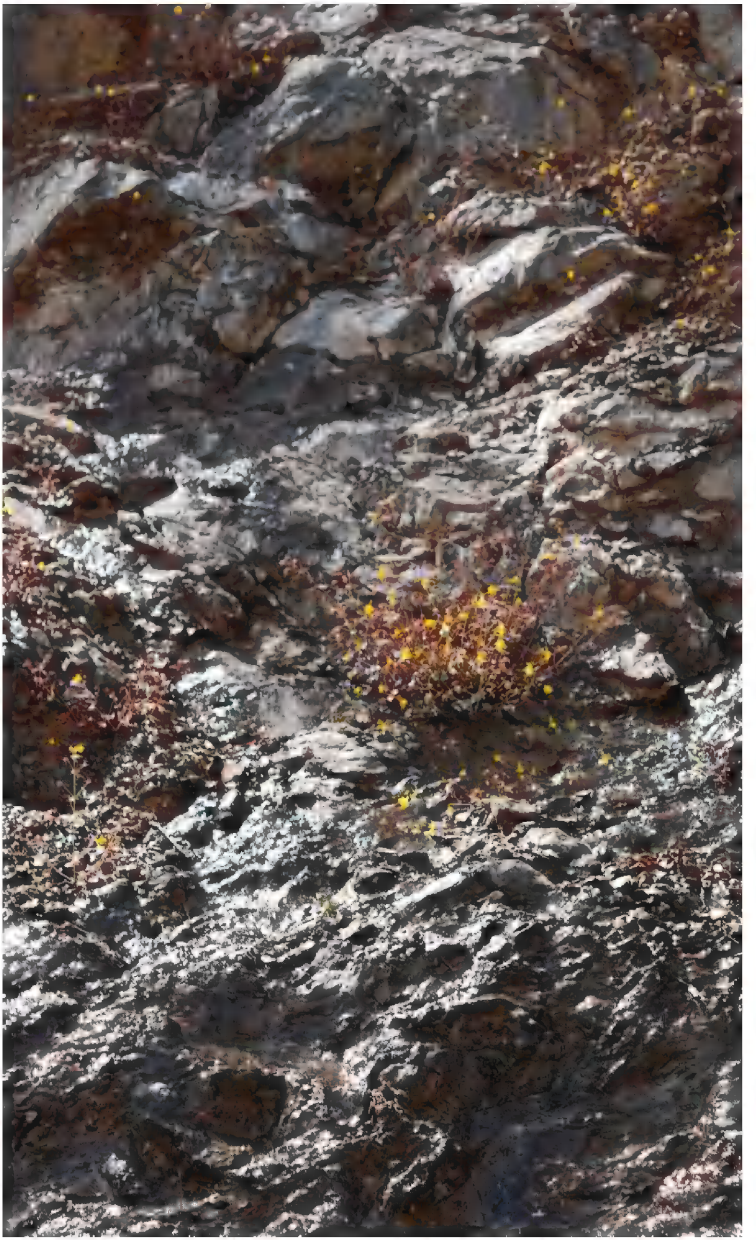

Figure 2. *Erythranthe percaulis*. Shallow soil pockets on wet serpentine faces.

Figure 3 (top and bottom). *Erythranthe percaulis*. In accumulated soil near base of slope.

Figure 4. *Erythranthe percaulis*. Habit, showing characteristically long internodes, reduced leaves and long, ascendant pedicels.

Figure 5. *Erythranthe percaulis*. Top. Plants of typical stature, in gravelly soil. Bottom. Relatively short plants in soil pocket.

Figure 6. *Erythranthe percaulis*. Dense cluster of plants mostly in mature fruit or nearly so.

Figure 7. *Erythranthe percaulis*. Mass of plants in soil pocket.

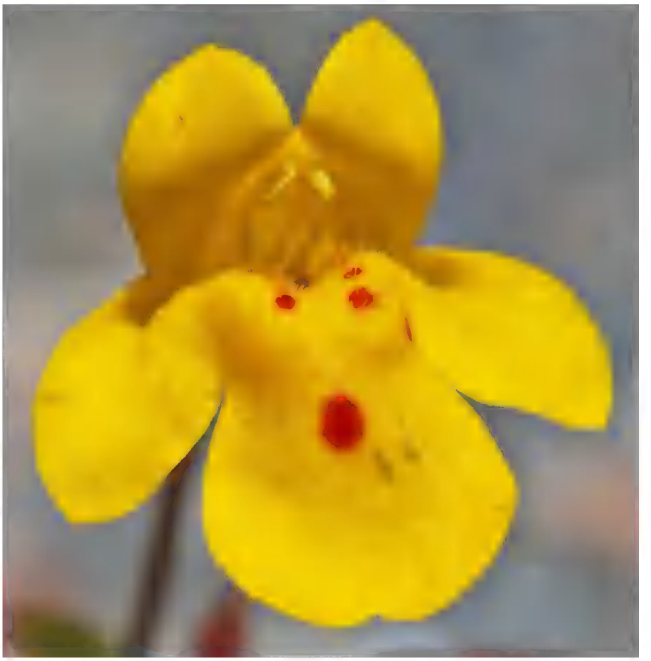

Figure 8. *Erythranthe percaulis*. Corolla -- the prominent red splotch or dot on the lower lip is characteristic, although this was not apparent in the pressed flowers of the type collection. The stigma usually protrudes slightly beyond the level of the anthers, supporting the earlier surmise by Nesom that the flowers are herkogamous.

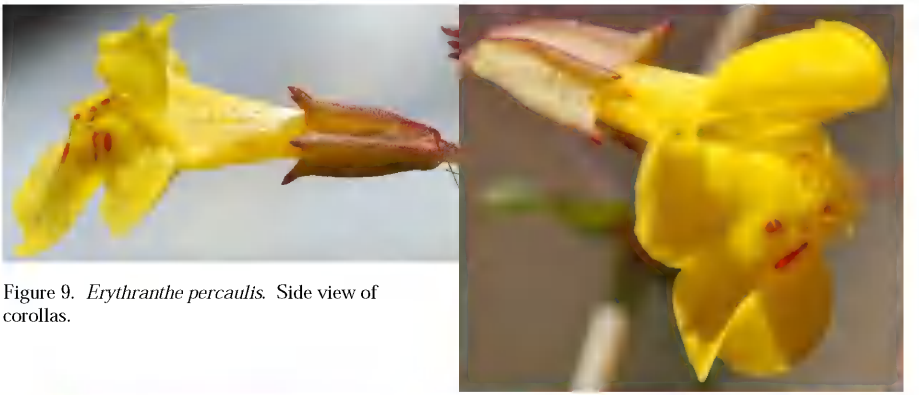

Figure 9. *Erythranthe percaulis.* Side view of corollas.

Figure 10. *Erythranthe percaulis.* Front view of corolla.

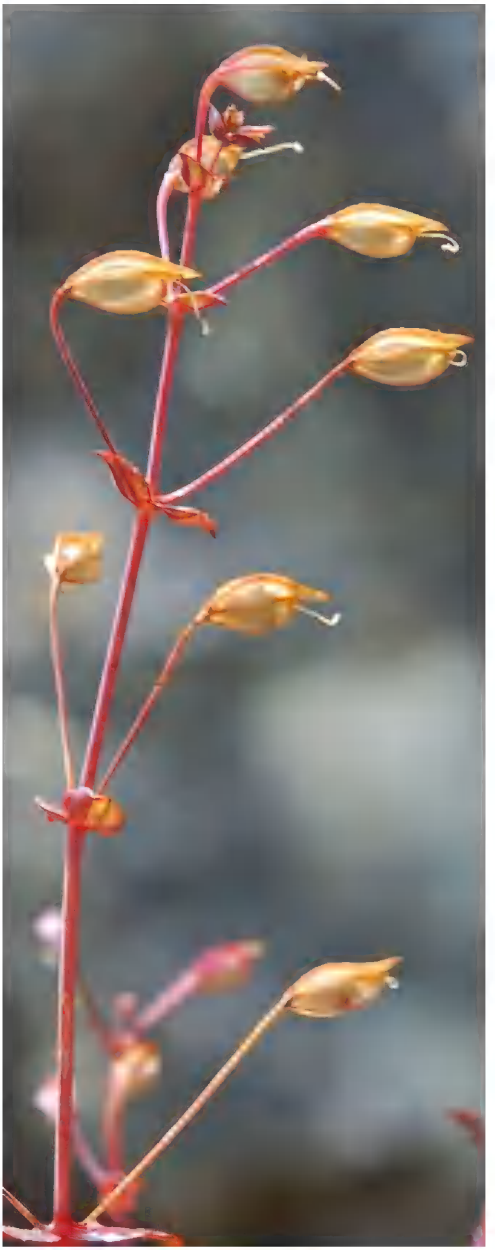

Figure 11. *Erythranthe percaulis*. Mature calyces, styles exserted.

Figure 12. *Erythranthe percaulis.* Small basal leaves and proximal cauline leaves.

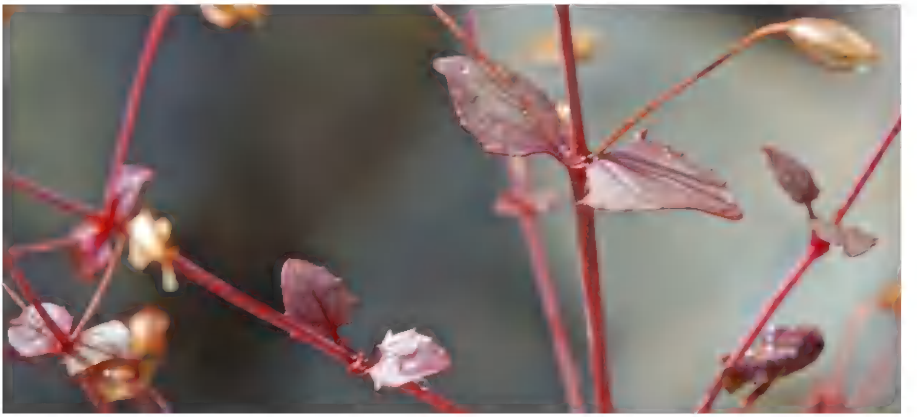

Figure 13. *Erythranthe percaulis*. Mid-cauline leaves.

Figure 14. *Erythranthe percaulis*. Plants with mostly basal leaves.

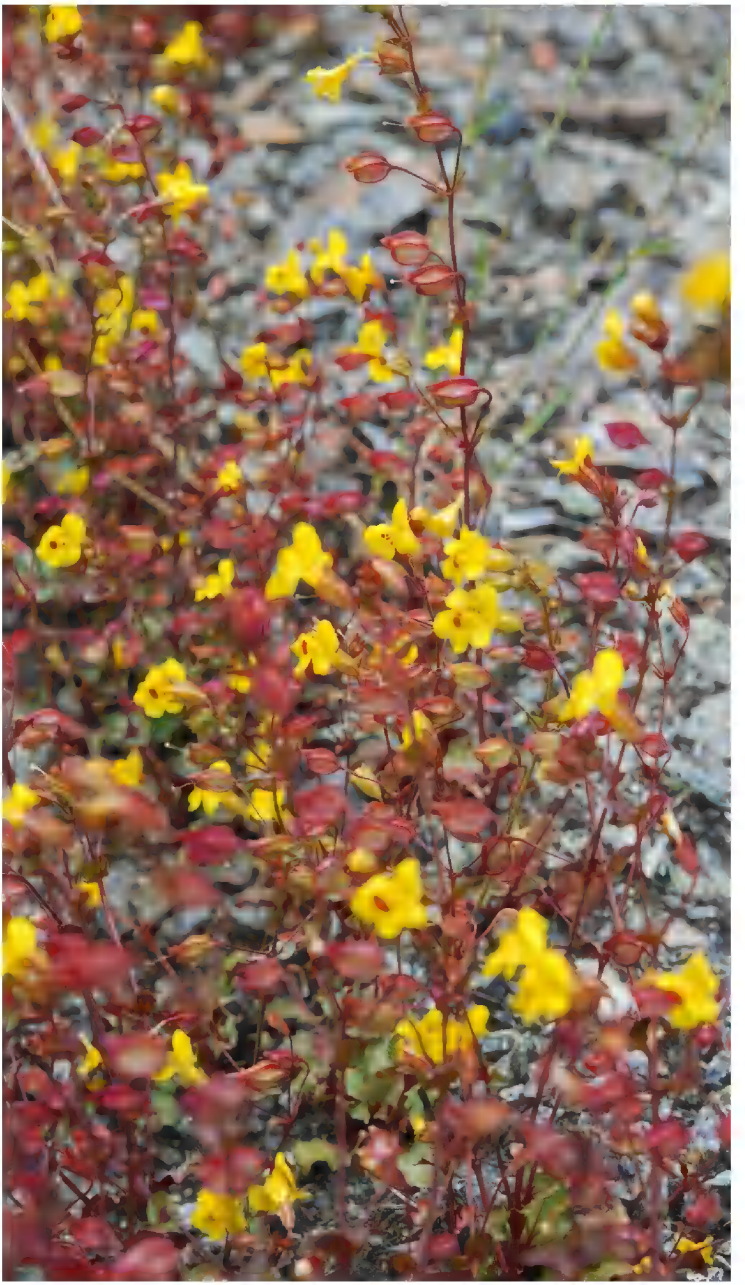

Figure 15. *Erythranthe microphylla* at the *E. percaulis* site. Mass of flowering plants.

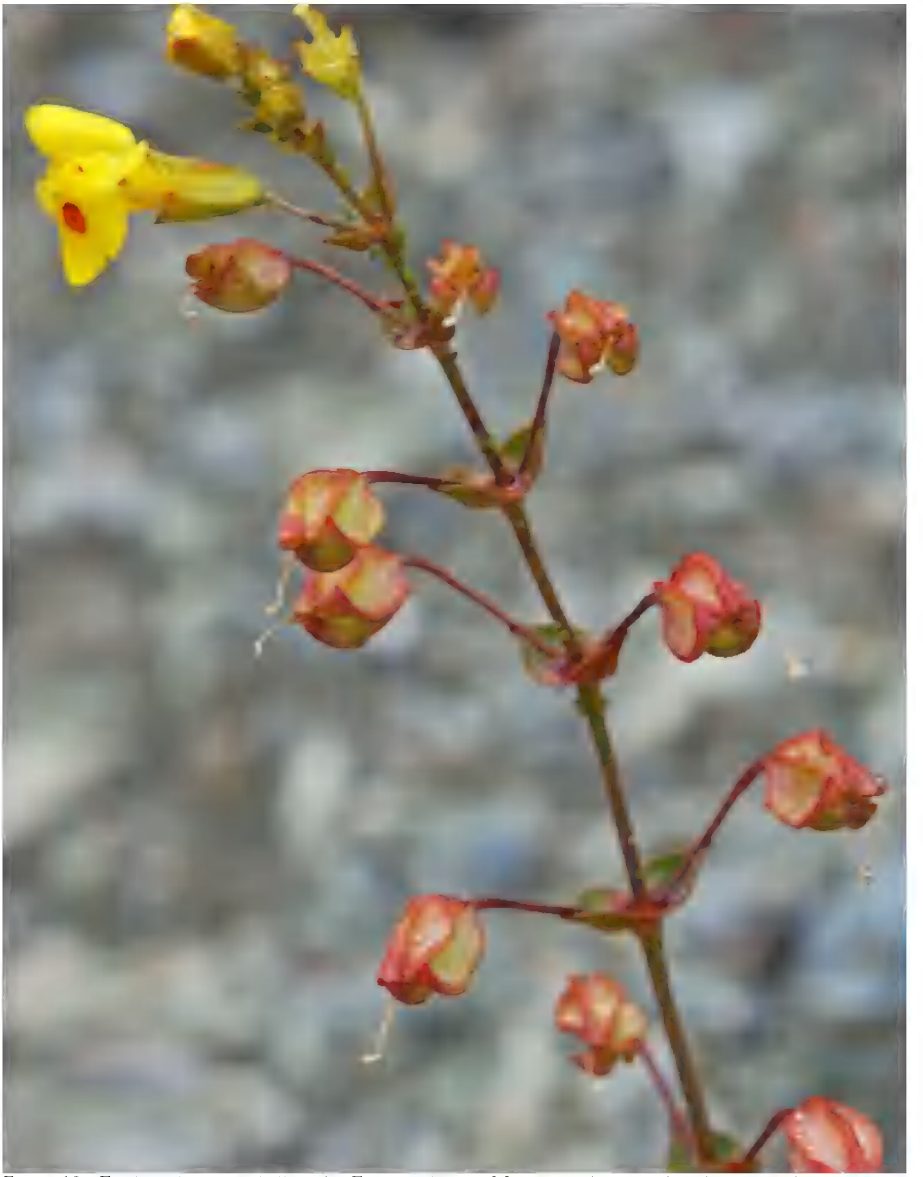

Figure 16. *Erythranthe microphylla* at the *E. percaulis* site. Maturing calyces, with styles exserted.

Diamond, A.R. 2016. New vascular plant county records from Alabama. Phytoneuron 2016-70: 1–6. Published 7 November 2016. ISSN 2153 733X

NEW VASCULAR PLANT COUNTY RECORDS FROM ALABAMA

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ABSTRACT

Three species and one variety of introduced vascular plants are reported as new to Alabama, and one native species excluded from the *Annotated Checklist of the Vascular Plants of Alabama*, and the Alabama Plant Atlas is documented as present in the state. Those species reported as new for the state are *Chloris canterae, Lupinus polycarpus, Phelipanche* [*Orobanche*] *ramosa,* and *Prunus persica* var. *nucipersica. Rudbeckia nitida* is confirmed as native and extant in Alabama.

New records for native and established exotic species have accumulated for Alabama as a result of field studies. Complete sets of the voucher specimens are housed at TROY, UWAL, and VDB. State records were determined using the Alabama Plant Atlas (Keener et al. 2016), the North American Plant Atlas (Kartesz 2015), and searches of literature.

CHLORIS CANTERAE Arechav. (Poaceae)

Voucher. **Alabama**. Conecuh Co.: Gravel parking lot, full sun, dry, disturbed soil, Evergreen, Industrial Park Road 0.4 mi S of Alabama Hwy 83, 31.451267° -86.967933°, 13 Jun 2015, *Diamond 26466*. Houston Co.: Dry sandy clay soil of roadside in full sun, Hilltop Road 0.04 mi N of Judge Logue Road, 31.200983° -85.678600°, 15 Oct 2015, *Diamond* with P.C. Harris *26928*.

Figure 1. *Chloris canterae* in a gravel parking lot in Conecuh County.

This represents the first reports of this taxon from Alabama. *Chloris canterae* is native to South America and has been previously reported as introduced in Georgia, Louisiana, Mississippi, South Carolina, and Texas in the USA (Barkworth 2003; Kartesz 2015; USDA, NRCS 2016). Two varieties have been reported as occurring in the USA: *C. canterae* Arechav. var. *canterae* and *C. canterae* var. *grandiflora* (Roseng. & Izag.) D.E. Anderson. The two varieties differ in disposition of leaves, width of leaves, and length of panicle branches. Our material corresponds to *C. canterae* Arechav. var. *canterae*. *Chloris canterae* was scattered at the Houston County locality, growing with *Cynodon dactylon* and *Paspalum notatum* on a sandy roadside maintained by mowing and herbicide application. The Conecuh County site was a gravel parking lot in full sun (Fig. 1). At this site *C. canterae* was the only species growing in much of the parking area.

LUPINUS POLYCARPUS E.L. Greene (Fabaceae)

Voucher. **Alabama**. Montgomery Co.: Roadside bank by cow pasture along Montgomery County Hwy. 17, 1/4 mi S of Co. Hwy 54, 32.346577° -86.430760°, 25 Mar 2012, *Diamond 22876*.

Figure 2. *Lupinus polycarpus* on roadside bank along a cow pasture in Montgomery Co., Alabama.

Native to California, Oregon, and Washington in the USA, this collection represents the first report of this taxon from Alabama. It has been reported as introduced in Wayne County Michigan (Kartesz 2015; USDA, NRCS 2016) where it was collected as a ballast waif in 1894 (Reznicek et al. 2016). *Lupinus polycarpus* is a small flowered annual species sometimes sold in "wildflower" seed mixtures. It is possible that the species was introduced to Alabama by this means. However, no other exotic species commonly included in wildflower seed mixes were observed at the site. The site is also located in a rural area of the county and not a "typical" site for wildflower plantings (Fig. 2). When first discovered, this site was adjacent to a hay field. After the area was fenced and cattle introduced this species disappeared from the pasture side of the fence. *Lupinus polycarpus* has been

observed at the site yearly since its discovery. Other species present at the site include *Scleranthus annuus*, *Plantago virginica*, *Hypochaeris glabra*, *Carex cherokeensis*, and *Salvia lyrata*.

PHELIPANCHE [Orobanche] **RAMOSA** (L.) Pomel (Orobanchaceae)

Voucher. **Alabama**. Montgomery Co.: Montgomery, sandy soil, grassy roadside in full sun at intersection of Co. Hwy 54 and Western Blvd, 32.344733° -86.371967°, 17 Mar 2016, *Diamond* with P.C. Harris *27259*.

Figure 3. *Phelipanche ramosa* on a roadside in Montgomery Co., Alabama.

This represents the first report of this taxon from Alabama. It has been reported from California, Illinois, Kentucky, South New Jersey, North Carolina, Texas, and Virginia in the USA (Kartesz 2015; USDA, NRCS 2016). *Phelipanche ramosa* is native to the regions surrounding the Mediterranean but is now a cosmopolitan weed of various crop species worldwide (Parker 2009). Several dozen individuals of this species were observed at the site growing among grasses and spring annuals (Fig. 3). This intersection is frequently utilized by persons setting up roadside stands to sell livestock and produce. Other species present include *Lolium perenne* var. *aristatum*, *Paspalum notatum*, *Sherardia arvensis*, *Trifolium campestre*, and *Trifolium incarnatum*.

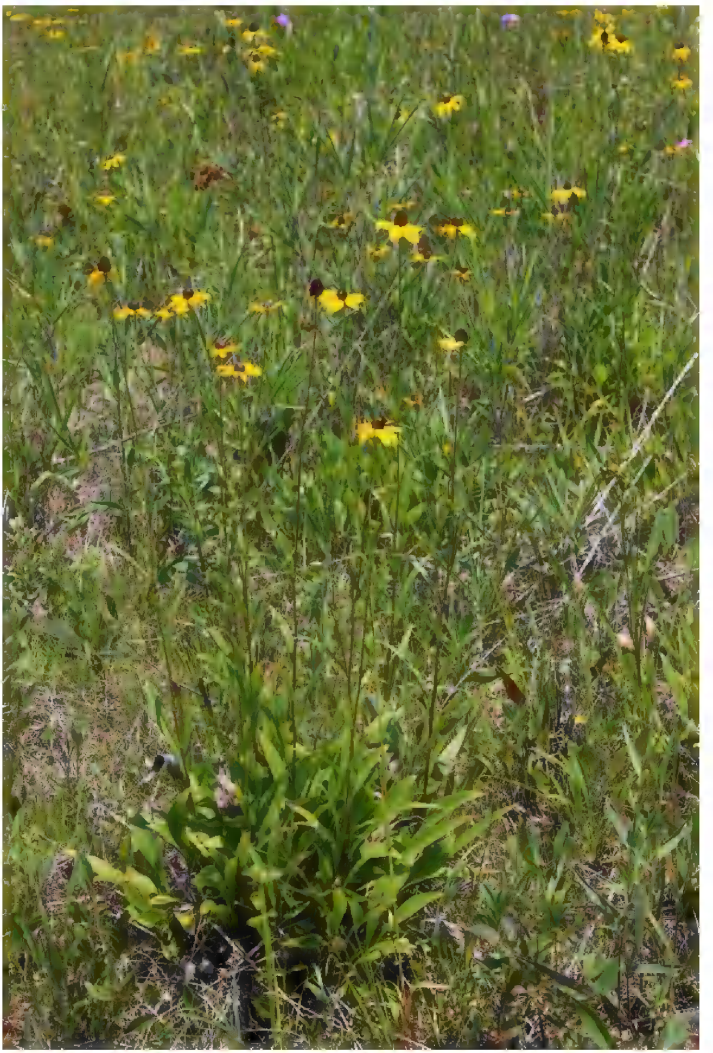

Figure 4. *Rudbeckia nitida* on a moist sandy roadside in Conecuh Co., Alabama

RUDBECKIA NITIDA Nutt. (Asteraceae)

Voucher. **Alabama**. Conecuh Co.: Common, moist sandy roadside in full sun, Co. Hwy 42, 1.5 mi SE of County Hwy 6; 31.246590° -86.753365°, 24 Jun 2016, *Diamond 27508*.

Confusion exists over the presence of this taxa in Alabama. This species has been reported from Macon and Monroe counties in Alabama (Kartesz 2015) and is also attributed to Alabama by the Plants Database (USDA, NRCS 2016) and Weakley (2015). However Urbatsch and Cox (2006) listed the native range of the species as Florida and Georgia in their treatment of the genus in Flora of North America and stated that "a report for Alabama has not been confirmed." Cronquist (1980) listed as range of the species as Florida and Georgia with "outliers in Manatee Co., Fla, and Macon Co., Ala." Kral (1983) gave the range of the species as Florida and Georgia with one occurrence "in east Alabama." When the *Annotated Checklist of the Vascular Plants of Alabama* was compiled (Kral et al. 2011), the committee developing the list was unable to locate a voucher of this species from Alabama and it was omitted from the list. The Alabama Plant Atlas website (Keener et al. 2016) was developed from the Alabama Checklist as a virtual environment which could be updated as flora data for Alabama is continually gathered and compiled. *Rudbeckia nitida* has not been added to the Plant Atlas website as occurring in Alabama. This collection serves to verify the presence of this taxa in the state.

PRUNUS PERSICA (L.) Batsch var. ***NUCIPERSICA*** (Suckow) C.K. Schneid. (Rosaceae)

Voucher. **Alabama**. Montgomery Co.: Montgomery, just N of Fourney Street (dirt) along a drainage ditch, fruit glabrous, 32.395784° -86.289900°, 10 May 2016, *Diamond* with B. Campbell *27379*.

This represents the first report of this taxon from Alabama. It has been reported from Georgia, Louisiana, South Carolina, and Texas in the USA (USDA, NRCS. 2016). *Prunus persica* var. *nucipersica* is a smooth-fruited sport of the common peach (resulting from a recessive allele) that has arisen many times in cultivation (Faust & Timon 1995). A single tree was present at the Alabama site. The area was heavily disturbed by storm water runoff and overflow of the drainage ditch and by city maintenance of the ditch and adjacent right-of-way. The area is also utilized as a "dump" by locals for tires, old appliances and furniture, household garbage, and lawn waste. Many exotic species were present at the site including *Ligustrum sinense*, *Liriope muscari*, *Rosa multiflora*, and *Triadica sebifera*.

ACKNOWLEDGEMENTS

I thank Michael A. Vincent, Curator of the Willard Sherman Turrell Herbarium (MU), for his identification of *Lupinus polycarpus* and Michael Woods of Troy University for his review of this paper.

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A NEW SPECIES OF *SYNECHANTHUS* (ARECACEAE: ARECOIDEAE: CHAMAEDOREEAE) FROM CENTRAL PANAMA

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ABSTRACT

Synechanthus dasystachys De Gracia & Grayum (Arecaceae), from the Atlantic slope of central Panama, is described and illustrated. The new species is unique in its genus in having consistently simple leaves and simple (unbranched) inflorescences. A revised key to the genus is presented, and *S. fibrosus* (H. Wendl.) H. Wendl. is reported from Panama for the first time.

RESUMEN

Se describe e ilustra *Synechanthus dasystachys* De Gracia & Grayum, de la vertiente atlántica de Panamá central. La especie nueva es única en su género por sus hojas consistentemente simples e inflorescencias simples (sin ramificarse). Se presenta una clave revisada del género, y se reporta *S. fibrosus* (H. Wendl.) H. Wendl. por primera vez en Panamá.

The new species of *Synechanthus* H. Wendl. (Arecaceae: Arecoideae: Chamaedoreeae) described in this paper was discovered during botanical inventory work in Donoso District, westernmost Colón Province, Panama, on the site of a large copper-mining concession currently administered by Minera Panamá S. A. This area, ranging in elevation from sea level to 431 m, has proved to harbor a unique flora that, since 2009, has yielded more than 20 previously undescribed species of vascular plants (De Gracia et al., in press), as well as numerous country records and other range extensions.

The palm flora in this region of Tropical Wet Forest (Holdridge et al. 1971) on the Atlantic slope is particularly diverse. An unpublished, largely vouchered list we maintain for the copper-mining site enumerates 45 palm species, including two in the genus *Synechanthus*: *S. warscewiczianus* H. Wendl., a common species ranging from Nicaragua to Ecuador, and the species described here as new, which seems to be a local endemic. The most recent revision of *Synechanthus* (Moore 1971) recognized just two species, *S. warscewiczianus* and the more northerly *S. fibrosus* (H. Wendl.) H. Wendl. The latter ranges from southern Mexico to westernmost Panama (Prov. Bocas del Toro), where it has been collected just once (*Santamaría et al. 7769*; CR, MO, PMA). We believe this to be the first reliable report of *S. fibrosus* from Panama. No new taxa have been described in

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Synechanthus since the publication of the aforementioned revision, so the genus is relatively easy to comprehend taxonomically. *Synechanthus* is broadly characterized morphologically among New World palms by its understory habit, leaflets acute to acuminate at the apex, inflorescences with four or five peduncular bracts, unisexual flowers borne in lines (acervuli) on the inflorescence rachillae, with the proximal flower of each acervulus pistillate and all the distal ones staminate (i.e., the plants are monoecious), sepals connate in a trilobed calyx in the flowers of both sexes, red or reddish, smooth ripe fruits, and seeds with ruminate endosperm.

A single plant of the new species described in this paper was encountered by the first author in the Donoso region in 2014, and a collection including both flowering and fruiting rachillae was prepared. Although grossly resembling certain species of the dioecious genus *Chamaedorea*, this individual exhibited both apparent stamens and mature fruits, suggesting monoecy and a closer affinity with *Synechanthus*. We knew at once that, if this were indeed a *Synechanthus*, it had to be an undescribed species, but we were unable to confirm our suspicions in the field. However, subsequent critical examination of this and additional material obtained in the same region have removed all doubt.

SYNECHANTHUS DASYSTACHYS De Gracia & Grayum, **sp. nov.** **TYPE: PANAMA. Colón**. Donoso Distrito, Minera Panamá copper-mining concession, along upper Río del Medio and on adjacent ridges, 8°50'26–31"N, 80°39'43–57"W, 110–219 m, 1 Sep 2014 (fl, fr), *M.H. Grayum, C. Ramos, I. Vergara-Pérez & L. Rojas 13293* (holotype: PMA; isotype: MO-6707796). Figures 1–7.

Differs from the other members of the genus by its consistently simple leaves and unbranched (spicate) inflorescences, with the rachis pilosulous and the acervuli densely disposed all around it.

Stem cespitose or (rarely) solitary, procumbent to erect, 0.5–1.5(–2.0?) m tall, 2–3 cm diam., brown, smooth, ringed. **Leaves** 5–10, simple; sheath 15–30 cm long; petiole green, 35–60 cm long, ca. 1 cm diam., sulcate adaxially; blade 45–85 × 15–30 cm, narrowly obovate, bifid (divided ca. 1/4–1/2 to the base), the distal lobes acuminate at apex, with 15–20 primary lateral veins per side. **Inflorescences** 2–5 per plant, infrafoliar, simple, bisexual; prophyll ca. 2 cm long, tubular, bicarinate; peduncle 24–37 cm long; peduncular bracts 5, 2–10 cm (the proximal 3) or 15–30 cm (the distal 2) long, fibrous; rachis 10–24 cm × 1.5–3.5 mm, acutely angled to narrowly winged longitudinally, pilosulous with uniseriate trichomes to ca. 0.3(–0.4) mm long, with lines of flowers (acervuli) distributed all around the circumference. **Flowers** cream-colored; **staminate flowers** (5)6 or 7(–10) in each acervulus, biseriate, ca. 1.5–2.0 mm tall, turbinate and ± strongly trigonous in bud, maturing basipetally; **calyx** deeply trilobed, the lobes ca. 1 × 1 mm, ovate to triangular, acute at the apex, weakly if at all nerved (when dried); **petals** 3, valvate, apparently connate basally, ca. 1.5 × 2.0 mm, broadly rhombic, subacute at the apex, strongly nerved (when dried); **stamens** 3, the filaments 2–3 mm long, inflexed distally in bud, long-exserted at anthesis, the anthers basifixed, ca. 1 mm long; **pistillode** absent (or not clearly evident); **pistillate flower** 1 and proximal in each acervulus, ca. 1.5–2.2 mm tall, subhemispherical and weakly trigonous in bud; **calyx** shallowly to deeply trilobed, the lobes 0.8–1.0 × ca. 2.0 mm, transversely rectangular or transversely oblong to semicircular or broadly triangular, subtruncate to broadly rounded at the apex, weakly nerved (when dried); **petals** 3, imbricate, apparently distinct, 1.5–2.0 × 1.5–3.0 mm, suborbicular and ± cucullate, rounded at the apex, strongly nerved (when dried); **staminodes** evident in all flowers examined, to at least 4, adnate to the petals, sometimes at least partly connate in a low ring basally, minute to ca. 0.5 mm long, rimlike to dentiform; **stigmas** 3, short, recurved. **Fruits** green to yellow or orange to red, 1.8–2.0 × 0.8–1.0 cm, narrowly oblongoid or ellipsoid to obovoid, smooth, glabrous, with basal stigmatic residue. **Seed** dark brown, ca. 15 × 6 mm, with ruminate endosperm. **Germination** and eophylls unknown.

Figure 1. *Synechanthus dasystachys*. Habit, with leaves (mainly adaxial surfaces) and very young infructescence. From *Vergara-Pérez et al. 1035* (photo by José De Gracia).

The new species is endemic to Panama and known by just six collections, all from the Distrito de Donoso, Provincia de Colón, in lowland tropical rainforest at elevations below 300 m (91–294 m). We estimate that only about 30 individuals have been located in the wild to date. Plants have been found with both flowers and fruits in March, September, and December.

Synechanthus dasystachys bears a strong superficial resemblance to various simple-leaved species of *Chamaedorea* Willd. (see, e.g., Hodel 1992), from which it may be distinguished by its monoecious (rather than dioecious) sexuality, with staminate and pistillate flowers borne together in lines (acervuli) on each inflorescence. In these respects, it accords more closely with *Gaussia* H. Wendl. (see especially Quero & Read 1986), an oligospecific genus of northern Mesoamerica and the Greater Antilles; however, the new species differs from *Gaussia* (and finds a home in *Synechanthus*) by virtue of its understory (vs. arborescent) habit (Dransfield et al. 2008: 370), sepals connate in a trilobed calyx (vs. distinct) in the flowers of both sexes (Henderson 1990: 9), and seeds with ruminate (vs. homogeneous) endosperm (Quero & Read 1986: 150–151). Our own observations confirm the foregoing differences and suggest that *Gaussia* is also distinct in having pistillate flowers that are smaller than the staminate flowers and with the petals valvate or subvalvate (at least distally), vs. subequal to or slightly larger than the staminate flowers and with the petals imbricate in *Synechanthus* (including our new species).

Figure 2. *Synechanthus dasystachys*. Top to bottom: Leaves (showing abaxial surface of upper leaf and adaxial surface of lower leaf), inflorescence, and three infructescences at varying stages (the uppermost with ripe fruits). From *Grayum et al. 13293* (photo by Christel Ramos).

Figure 3. *Synechanthus dasystachys*. Top to bottom: Three infructescences at varying stages (the lowermost with ripe fruits) and inflorescence at anthesis (with portion of rachis toward right; note exserted stamens). From *Grayum et al. 13293* (photo by Christel Ramos).

Figure 4. *Synechanthus dasystachys*. Section of inflorescence, showing staminate (triangular) and pistillate (rounded, e.g., left of center) flowers, all in bud; dark spots are scars of fallen staminate flowers. Note also pubescence (especially near left side of image). From *Vergara-Pérez et al. 1035* (photo by José De Gracia).

Figure 5. *Synechanthus dasystachys*. Staminate flower at anthesis (with adjacent pistillate bud at left; note imbricate aestivation of petals). From *Vergara-Pérez et al. 1035* (photo by José De Gracia).

Figure 6. *Synechanthus dasystachys*. Nearly mature fruits. From *Vergara-Pérez et al. 1055* (photo by José De Gracia).

Figure 7. *Synechanthus dasystachys*. Ripe seed. From *Vergara-Pérez et al. 1075* (photo by José De Gracia).

It may seem imprudent of us to be describing a new species in *Synechanthus*, given the notorious morphological variability of one of the established species, *S. warscewiczianus* (see, e.g., Moore 1971). Yet, *Synechanthus dasystachys* differs notably from both of its congeners in having consistently simple, bifid leaves and unbranched (spicate) inflorescences, with the rachis relatively thick and pilosulous and the acervuli disposed comparatively densely (especially proximally) all around it (the flowers of each sex being distinguishable by their slightly different sizes and, especially, shapes and aestivation types). Both of the other species in the genus typically have pinnately compound leaves, but *S. warscewiczianus* varies remarkably in this regard, and populations with simple leaves have been documented (see, e.g., Grayum 2003: 292); indeed, simple-leaved individuals of *S. warscewiczianus* apparently occur in the Donoso region, if we may accept the comments of Meerman (2009: 14) associated with his photos labeled "*Hyospathe elegans*" (but which clearly depict *S. warscewiczianus*).

The two previously recognized species of *Synechanthus* always have branched inflorescences, so far as we know, typically with 17–75 rachillae. But here again, *S. warscewiczianus*, as presently circumscribed, is highly variable and populations with reduced

numbers of inflorescence rachillae are especially frequent in central Panama, whence specimens with as few as three rachillae have been collected (e.g., *Croat 14277*, MO; *Mori & Kallunki 2730*, MO). The rachillae of these aberrant specimens are, however, filiform (ca. 0.8–1.5 mm thick), glabrous, and with distichous acervuli, as typical of *S. warscewiczianus* but not *S. dasystachys*; moreover, the specimens in question all have pinnately compound leaves. The new species agrees with *S. fibrosus* in having relatively few staminate flowers per acervulus, but its individual staminate flowers have just three stamens with the filaments inflexed distally in bud and long-exserted at anthesis, as is characteristic of *S. warscewiczianus* (see, e.g., Grayum 2003: 290). According to our investigation, the "minutely scaberulous" (Moore 1971: 12, 14) inflorescence rachillae of *S. fibrosus* often scarcely differ perceptibly from the glabrous or glabrate rachillae of *S. warscewiczianus*; however, on some specimens of *S. fibrosus* (e.g., *Rivera H. et al. 1234*, MO; southern Mexico), this "scaberulous" rachillar indumentum rises nearly to the level of pilosulous or hispidulous (at least on a microscopic level), differing from that of *S. dasystachys* only by degree (the individual enations or trichomes never attaining even 0.1 mm in *S. fibrosus*). We carefully considered the possibility that *Synechanthus dasystachys* might have been described previously in another genus (particularly *Chamaedorea*) but believe we have falsified that hypothesis to our satisfaction.

Once the significance of our discovery was realized, we conducted thorough herbarium searches at MO and PMA for additional material of our new species, not only in the *Synechanthus* folders but also those for related or superficially similar genera including *Chamaedorea*, *Gaussia*, *Geonoma* Willd., and *Hyospathe* Mart., as well as palm specimens undetermined to genus. This search (which included South American material) yielded but a single additional specimen of *S. dasystachys*: *McPherson & van der Werff 20004* (MO, PMA), also from the Donoso region, collected during the early stages of the mine-site inventory. Rather embarrassingly, this collection (with immature fruits) had been examined previously by the first author of this paper, who determined it (in 2008) as *Chamaedorea deckeriana* (Klotzsch) Hemsl.! The last-mentioned species is indeed strikingly similar (especially in fruit) to *Synechanthus dasystachys* in its gross morphology, and as the latter was not yet known to exist, no genus other than *Chamaedorea* was considered in identifying this specimen, hence acervuli were not sought (though the scars of the fallen staminate flowers are clearly visible under the dissecting scope, in linear formation). There is also evidence that *S. dasystachys* was encountered at some point between June 2007 and February 2009 by by J.C. Meerman, an ecologist based in Belize who inventoried palms and cycads at the Donoso mine site during that period. Meerman, with a good general knowledge of Central American palms, produced an illustrated guide for the mine site (Meerman 2009) but prepared no herbarium vouchers (indeed, it was a need for proper palm vouchers that instigated our work). Meerman's photos (2009: 11) labeled "*Geonoma* cf *cuneata*" almost certainly depict *Synechanthus dasystachys* (no *Geonoma* species known to us has yellow fruits), but in the absence of a voucher, it is impossible to be certain. Likewise unverifiable are Meerman's comments about his "*Geonoma* cf *cuneata*," which state that the leaves can "rarely" be pinnate. While such leaf dimorphy has been documented for many palm species (including the real *Geonoma cuneata* H. Wendl. ex Spruce), none of the specimens of *S. dasystachys* in our possession has pinnate leaves, and Meerman may have been conflating two or more species in his account.

The epithet of the new species name, a noun used in apposition, reprises the long-abandoned genus name *Dasystachys* Oerst., established originally (Örsted 1859: 25–26) to accommodate the palm species now known as *Chamaedorea deckeriana*, to which our new species bears a close superficial resemblance. The literal meaning of the name, from the Greek *dasys* (= hairy or dense) and *stachys* (= spike), is also especially apt (in both senses of its first element) for the new species.

Additional material examined. PANAMA. Colón: Teck Cominco Petaquilla mining concession, streamside forest by old Petaquilla camp, 8°50'14"N, 80°41'17"W, 91 m, 6 Dec 2007 (fr), *McPherson & van der Werff 20004* (MO, PMA); Donoso, área de concesión del proyecto Minera

Panamá S. A., Valle Grande, antiguas oficinas MPSA, quebrada arriba hacia Patio Limoso, 8°49'35.2"N, 80°40'16.2"W, 294 m, 04 Nov 2015, *Vergara-Pérez et al. 1035* (PMA); Donoso, área de concesión del proyecto Minera Panamá S. A., Valle Grande, antiguas oficinas MPSA, quebrada arriba hacia Patio Limoso, 8°49'35.2"N, 80°40'16.2"W, 294 m, 10 Dec 2015 (fr), *Vergara-Pérez et al. 1055* (MO, PMA); Donoso, área de concesión del proyecto Minera Panamá S. A., antiguas oficinas MPSA, quebrada abajo hacia Río Petaquilla, 8°49'32.7"N, 80°40'42.6"W, 153 m, 11 Dec 2015 (fl, fr), *Vergara-Pérez et al. 1056* (MO, PMA); Donoso, área de concesión del proyecto Minera Panamá S. A., TMF, Cofferdam Jujuca, 8°53'24.9"N, 80°40'31.6"W, 105 m, 20 Mar 2016 (fl, fr), *Vergara-Pérez et al. 1075* (MO, PMA).

REVISED KEY TO THE SPECIES OF *SYNECHANTHUS*

1. Leaves simple and bifid; inflorescences simple (unbranched), the rachis 1.5–3.5 mm thick, pilosulous with trichomes to 0.3(–0.4) mm; acervuli distributed all around the rachis; central Panama ..... **Synechanthus dasystachys**

1'. Leaves pinnately compound, rarely simple and bifid; inflorescences racemosely to paniculately branched, the rachillae (3–)17–75, ca. 0.8–1.5 mm thick, glabrous or glabrate or, if minutely scaberulous, with enations or trichomes <0.1 mm; acervuli mostly distichous on the rachillae; southern Mexico to Ecuador.

2. Inflorescences paniculately or subpaniculately branched (at least one basal branch itself branching or bifurcate); leaves always pinnately compound, the leaflets in interrupted groups, arranged in various planes (at least in the proximal half), subsigmoid; staminate flowers 5–7 per acervulus; stamens 6, the filaments included at anthesis, the anthers subequal to or longer than the filaments; southern Mexico to westernmost Panama ..... **Synechanthus fibrosus**

2'. Inflorescences racemosely branched (all the branches simple); leaves simple (rarely) or, if pinnately compound, then the leaflets regularly or irregularly spaced (but not in groups), arranged in a single plane, and more or less straight; staminate flowers 6–15 per acervulus; stamens 3, the filaments long-exserted at anthesis, the anthers much shorter than the filaments; Nicaragua to Ecuador ..... **Synechanthus warscewiczianus**

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SOLIDAGO MAYA, (ASTERACEAE: ASTEREAE: *SOLIDAGO* SUBSECT. *MARITIMAE*) A NEW SPECIES OF GOLDENROD FROM SOUTHERN MEXICO, GUATEMALA, AND BELIZE

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ABSTRACT

A new species of *Solidago* subsect. *Maritimae*, **Solidago maya** Semple, **sp. nov.**, is described from collections made in the highlands of Chiapas, Mexico, and the Maya Mountains of eastern Guatemala and Belize. The species is most similar to *S. mexicana* and *S. virgata*.

Solidago subsect. *Maritimae* (Torr. & Gray) G.L. Nesom includes 13 species of goldenrods occurring in bogs, marshes, seepage, and other normally continuously moist habitats. All species have basal rosette and lower stem leaves that sheath the stem, while middle and upper stem leaves do not. Inflorescences vary from elongated, narrow (short branched) to conical (longer lower branched) arrays that are apically secund (most species) to non-secund, with some species including both secund and non-secund arrays. Differences in the degree of apical dominance determine whether or not lower branches of larger inflorescences remain short and suppressed or are elongated. In some cases, only the lowermost branches are greatly elongated. Different growth forms of the arrays are illustrated in Semple (2012, 2013, 2016 frequently updated).

Among members of subsect. *Maritimae*, Semple (2013) clarified the misapplication of the name *Solidago stricta* sensu authors (including Semple & Cook 2006) to the southeastern USA coastal plain taxon that has non-serrate lower stem leaves and narrow, apically non-secund inflorescences with short branches regardless of the robustness of the shoot; these plants are correctly treated as *S. virgata* Michx. The name *S. stricta* Ait. is correctly applied to the rare eastern Virginia and southern New Jersey pine baron taxon with serrate lower stem leaves and inflorescence that have long ascending-diverging lower branches in robust shoots. Mexican members of subsect. *Maritimae* are *S. paniculata* DC., native to central Mexico in wetter areas of the Mexico City region and eastern Michoacán, and *S. mexicana* L., native along the Gulf coast of Tamaulipas, Veracruz, and Tabasco in dunes at low elevations. Collections of the coastal plants have been identified as S. *mexicana*, *S. sempervirens* var. *mexicana* (L). Fern. (or subsp. *mexicana* (L.) Semple), or as *S. stricta* sensu authors not Ait.

Plants from the highlands of Chiapas, Mexico and the Maya Mountains of eastern Guatemala and southwestern and central Belize have been identified as *Solidago mexicana* (and synonyms) or *S. stricta* but they are not identical to the Gulf coastal plants. McVaugh (1972) noted the occurrence of these plants in Chiapas and concluded they were similar to *S. stricta* (sensu auth. not Ait.). Following McVaugh, Nash (1976) treated the highland plants as *S. stricta*. Semple et al. (2016) have presented a multivariate morphometric analysis of the *S. sempervirens* L. complex, which includes the plants from Chiapas, Guatemala, and Belize. Statistical support was found for recognizing these highland plants as a separate species.

SOLIDAGO MAYA Semple, **sp. nov.** **TYPE**: **MEXICO**. **Chiapas**. Mpio. San Cristobal Las Casas, extensive marsh at S end of the Valley of San Cristobal, elev. 2200 m, 23 Oct 1971, *D.E. Breedlove & R. Thorne 21282* (holotype: MO). Figures 1-3.

Solidago maya is similar to *S. mexicana* from Texas and Mexico but differs from it in having fewer stem leaves, shorter midstem leaves, slightly wider midseries phyllaries, and slightly smaller ray floret ovaries at anthesis. As well, involucre height averages about a half a millimeter less in *S. maya* (3.9 mm) than in western *S. mexicana* (4.45 mm). *Solidago maya* is known from the mountains of Chiapas, Mexico, and the Maya Mountains of eastern Guatemala and southwestern and central Belize, while *S. mexicana* occurs at near sea level along the Mexican coast from Tamaulipas to Tabasco and north to Maryland along the Gulf and Atlantic coasts of the USA.

Plants 39–**68**–102 cm, rootstock a short, thick, decumbent to ascending woody caudex, single- to multi-stemmed. **Stems** erect, proximally glabrous, distally glabrous to sparsely strigose in inflorescence. **Leaves**: basal rosette and lowest stem leaves narrowly oblanceolate, 60–**110**–230 × 7–**12**–20 mm, tapering to winged petiole, the petiole base sheathing the stem or nearly so, entire, apex usually somewhat spinulous; mid stem leaves sessile, blades narrowly lanceolate, 18–**44**–75 × 2–**5.7**–12 mm, tapering to sessile base, shiny glabrous, apices acute, margins entire, sometimes ciliate; upper stem leaves sessile, blades narrowly lanceolate to linear lanceolate, 14–**29**–50 × 1.5–3.5–7.5 mm, much reduced distally, glabrous, margins entire. **Heads** 25–150+, in narrow thyrsiform or apically secund conical arrays (Fig. 4) 8–**20**–31 cm tall × 2–4.3–14.5 cm wide, branches 1.5-10 cm, usually ascending to somewhat diverging, heads secund on longest branches of large arrays, bracts few to many, linear lanceolate. **Peduncles** 1–15 mm, glabrous to moderately short villoso-hirtellous; bracteoles few, often distal, grading into phyllaries, very linear-lanceolate. **Involucres** cylindrical when fresh, but spreading distally when pressed, 3–**3.8**–4.7 mm. **Phyllaries** in 3–4 series, broadly to narrowly lanceolate, unequal (outer 1/4–1/3 length of inner), margins entire to slightly fimbriate distally, apices acute, glabrous; central vein thicker basally. **Ray florets** 1–**6**–8; laminae yellow 1.6–**2.3**–3 × 0.6–**0.73**–0.9 mm; ovary 0.5–**0.83**–1.1 mm at anthesis, sparsely to moderately strigillose, pappi 2.8-**3.4**-4.1 mm at anthesis, longest slightly clavate, others narrow, tapering. **Disc florets** yellow, 5–**9**–12; corollas 2.9–**3.8**–4.5 mm, lobes 0.6–**0.9**–1.3 mm; ovary (narrowly obconic) 0.5–**0.1.2**–1.5 mm at anthesis, sparsely strigillose; pappi 2.8–**3.6**–4.2 mm, longest slightly clavate. **Mature cypselae**: fruit body 1.7–2.3 mm, pappi 3.2–4.3 mm. **Chromosome number**: unknown. Means in **bold face**.

Distribution and habitat. The species occurs predominantly in the Sierra Madre de Chiapas of central Chiapas, Mexico, and disjunct in the Maya Mountains of eastern Guatemala and Belize. Bogs, shrubby second growth slopes, moist pastures, grasslands, pinelands, forests, on steep moist slopes with *Quercus* spp.; 460–2160 m (1500–7100 ft). Elevations are 1060–2160 m in Chiapas, ca 460 m in Guatemala and Belize. *Solidago maya* is allopatric with other native species of *Solidago* in Mexico and Central America.

Etymology. The species epithet is a noun in apposition honoring Mayan people in the general area where the species occurs.

Collections examined. **BELIZE**. Dept. Cayo: Mt. Pine Ridge, Skyline Drive, in grassland, 21 Jun 1967, *Brunt 2289* (BM). **GUATEMALA**. Dept. Petén: 3 km W of village of Dolores, pineland, 19 Apr 1961, *Contreras 2135* (F, MO). **MEXICO**. **Chiapas**. No date, *Ghiesbreght 124* (GH); about Ocuilapa, table land, 21 Aug 1895, *Nelson 3006* (GH); Salul Ja, 5 km E of la cabecera de Amatenango, bosque, 3 Sep 1988, *J. Lopez Pérez 420* (TEX); Mpio. Ocosingo, 16 km NE of Oxchuc along road to Ocosingo, shrubby second growth slope, 23 Sep 1972, *Breedlove 27763* (F, MO); Mpio. San Cristobal las Casas, S end of the valley of San Cristobal las Casas, large bog, 3 Aug 1966, *Breedlove 14705* (F), S end of Valley of San Cristobal, bog, 24 Aug 1964, *Breedlove 7108* (F); Mpio. Tenejapa, Tenejapa, on steep moist slope with *Quercus* spp. in the paraje of 'Oshe Wits, 28 Nov 1964, *Breedlove 7769* (F); Mpio. Teopisca, NE edge of Teopisca along MEX-190, large moist pasture, 25 Jun 1965, *Breedlove 10540* (F). McVaugh (1972) cited several additional collections that I have not seen.

Figure 1. Holotype of *Solidago maya* Semple: *Breedlove & Thorne 21282* (MO).

Figure 2. Details of holotype of *Solidago maya*: stem and leaves. **A-C**. Lower, mid and upper stems. **D**. Inflorescence branch and peduncle. **E**. Basal rosette leaves. **F-H**. Lower mid stem leaf and adaxial surface details. **I-J**. Upper stem leaves. Scale bar = 1 cm in E-G and I-J; = 1 mm in A-D, and H.

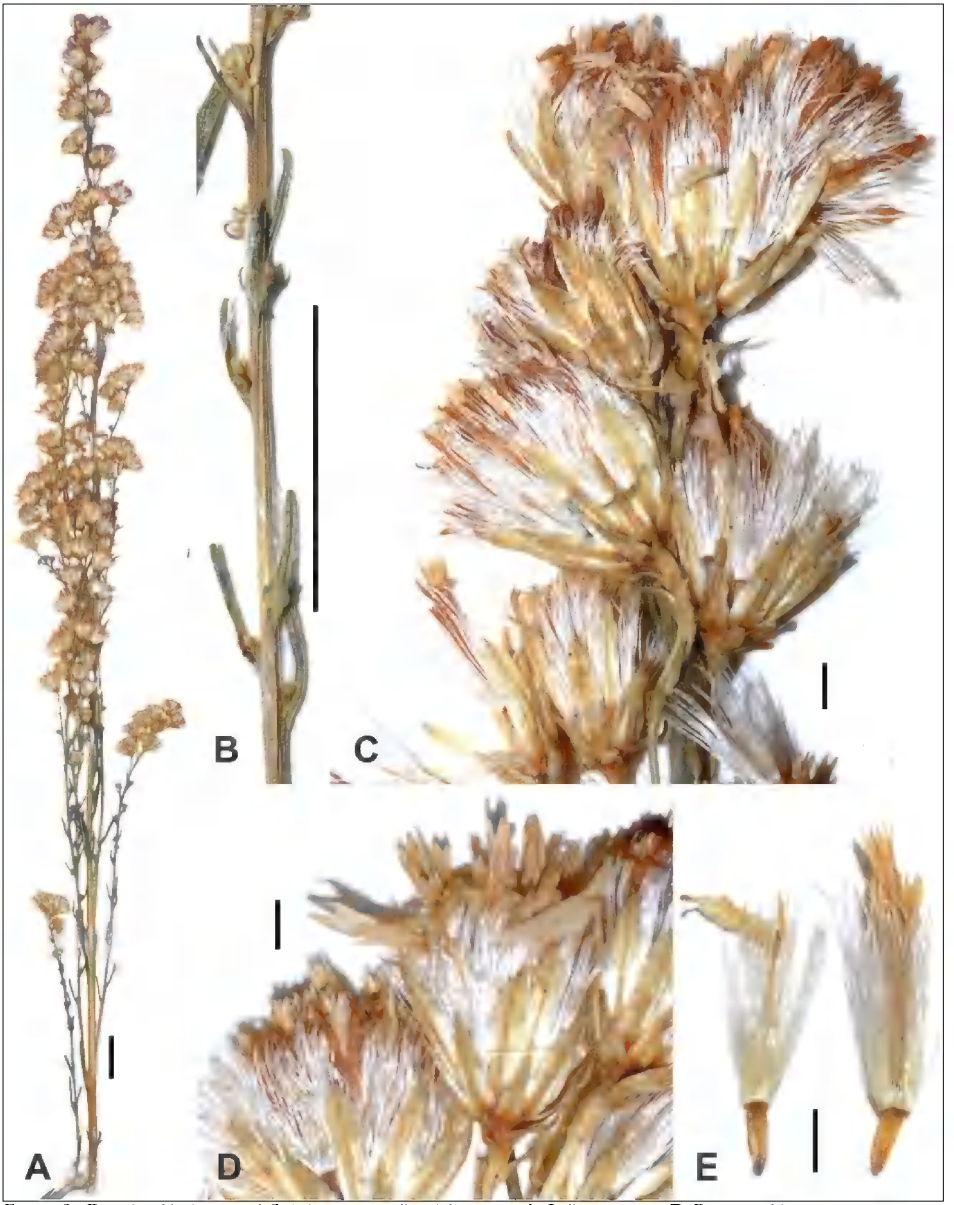

Figure 3. Details of holotype of *Solidago maya*: floral features. **A**. Inflorescence. **B**. Portion of lower inflorescence branch and bracts. **C**. More mature heads. **D**. Flowering heads. **E**. Ray and disc floret at anthesis. Scale bar = 1 cm in A-B; = 1 mm in C-E.

Figure 4. Inflorescence array variation in *Solidago maya*: floral features. **A.** *Ghrisbacht 124* (GH). **B.** *Breedlove 27763* (F). **C.** *López Pérez 420* (TEX). **D.** *Contreras 2135* (F). Scale bar = 10 cm in A-C; 1 cm in D.

Solidago maya is most similar to some diploid plants of *S. mexicana* from Florida and to diploids of *S. virgata* from Florida, less so to tetraploids of *S. mexicana* from coastal Texas and Mexico and even less so to *S. sempervirens* and *S. azorica*. A multivariate morphometric analysis of the *S. sempervirens* complex plus *S. virgata* of the *S. stricta* complex was undertaken to clarify morphological limits of the taxa involved (Semple et al. 2016). The study included 38 vegetative and floral traits scored on 119 specimens of the *S. sempervirens* complex of *Solidago* subsect. *Maritimae* (*S. azorica*, *S. maya*, *S. mexicana*, *S. paniculata*, and *S. sempervirens*) and *S. virgata* of the *S. stricta* complex. In the multivariate study, *S. maya* separated weakly to strongly from other taxa depending upon the number of a priori groups included in an analysis and whether or not *S. mexicana* samples were treated as a single a priori group or were split into eastern (diploid) and western (tetraploid) a priori groups. In the analysis comparing just *S. maya* and western *S. mexicana*, all nine specimens of *S. maya* were placed a posteriori into the *S. maya* group (6 specimens 96-100% probability, including the holotype; one specimen each with 87%, 76%, and 70% probabilities). Specimens of *S. maya* from across the range in central and eastern Chiapas and eastern Guatemala and Belize were included in the analysis. The details of the study are presented in Semple et al. (2016) and are not replicated here.

The inflorescence variation illustrated in Fig. 4 is similar to that occurring in *S. mexicana*. Small inflorescences with relatively few heads are similar to small inflorescences of *S. austrina*, *S. gracillima*, *S. stricta*, and *S. virgata*, but the larger arrays have a branching pattern that does not occur in *S. virgata*, which retains the narrow non-secund wand-shaped form even in robust plants. The holotype does not appear to have the secund apex usually present in mid to large arrays of *S. mexicana*, but its lower long proximally ascending to distally diverging branches are like the lower longer branches in arrays of *S. mexicana*. The branching patterns of larger arrays of *S. austrina*, *S. gracillima* and *S. stricta* are different than those of *S. maya* in the branching angle, the number of elongated lower branches and in the amount of branch curvature.

Nash (1976) noted the occurrence of what she referred to as *Solidago stricta* in Chiapas and assumed that it was likely present in adjacent Guatemala and cited McVaugh (1972). Her illustration of "*S. stricta*" (Fig. 40, p. 495) is *S. maya*. The illustration does not match any of the collections listed above.

No collections of *Solidago maya* from the central and western highlands of Guatemala were seen among specimens at BM, F, GH, MO, and TEX. John Pruski (pers. comm., September 2016) of the Missouri Botanical Garden indicated that the apparent gap may be real because the area between the disjunct populations is lower in elevation, although there has been only limited collecting in this area.

Key to species of *Solidago* subsect. *Maritimae* in Mexico, Guatemala, and Belize
(All species have basal rosette and lower stem leaves with leaf bases sheathing or nearly sheathing the stem.)

1. Upper stem leaves not greatly reduced, 85–110 × 12–15 mm; inflorescences usually leafy; introduced in Veracruz, Mexico ..... **Solidago sempervirens**
1. Upper stem leaves reduced, 10–77 × 1.5–7 mm; native to Mexico and Guatemala; inflorescences with reduced leaves.
   2. Rays 9–21 averaging 15, native to Mexico D.F. and Michoacán, Mexico . **Solidago paniculata**
   2. Rays 6–10 averaging 5–7; Gulf coastal plain of Mexico and highlands in Chiapas, Guatemala and Belize.
      3. Upper 1/4 of stem usually with short nodes and many leaves (averaging 25); 0–30 m elev., Gulf coastal plain, Mexico from Tamaulipas to Tabasco ..... **Solidago mexicana**
      3. Upper 1/4 of stem with few leaves (averaging 9); 460–2200 m elev., highlands in central Chiapas and Guatemala ..... **Solidago maya**

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A MULTIVARIATE STUDY OF THE *SOLIDAGO SEMPERVIRENS* COMPLEX (ASTERACEAE: ASTEREAE: *SOLIDAGO* SUBSECT. *MARITIMAE*)

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ABSTRACT

A multivariate morphometric study of the *Solidago sempervirens* complex of *S.* subsect. *Maritimae* was performed to assess statistical support for recognizing *S. azorica*, *S. maya*, *S. mexicana*, *S. paniculata* and *S. sempervirens* as separate species. Specimens of *S. virgata* of the *S. stricta* complex of subsect. *Maritimae* were also included in some analyses. Nine analyses were run, including all or only some of the species. In several analyses, eastern and western specimens of *S. mexicana* were split into two a priori groups. *Solidago paniculata* and *S. azorica* were determined to be the most distinct species in the complex based on both leaf and floral traits. *Solidago maya* was found to be most similar to eastern specimens of *S. mexicana* and to some specimens of *S. virgata* from the southeastern USA. *Solidago maya* has the lowest leaf density in the complex and has inflorescences that are sometimes not apically secund. All species of the *S. sempervirens* complex occur at 0-40 m elevations in coastal plain moist soils and coastal marshes and dunes with the exception of *S. maya*, native to 460-2200 m elevation in Belize, Guatemala, and Chiapas, Mexico and *S. paniculata* native to central Mexico. *Solidago sempervirens* is adventive further inland in eastern North America at higher elevations along roads that are salted in the winter, and it appears to be introduced in a few locations in Florida, Louisiana, and Mexico. The native ranges of distribution of *S. azorica*, *S. maya*, *S. mexicana*, *S. paniculata*, and *S. sempervirens* are completely or mostly allopatric. Robust individuals are generally easily identified, but smaller or damaged individuals can be more problematic in placing to species.

Solidago subsect. *Maritimae* (Torr. & Gray) G.L. Nesom includes all the bog and marsh goldenrod species with sheathing proximal basal rosette and lower stem leaves. The *Solidago sempervirens* L. complex includes 1) the seaside goldenrods *S. azorica* Hochstetter ex Seubert, *S. mexicana* L., and *S. sempervirens* L. native to eastern North America and some islands in the North Atlantic and 2) two inland species, *S. maya* Semple and *S. paniculata* DC., native to central and southern Mexico, Belize, and eastern Guatemala. These species all have inflorescences that are usually narrowly to broadly secund conical in shape, although *S. paniculata* sometimes has ascending spreading lower branches making the inflorescence somewhat corymbiform. *Solidago azorica* and *S. mexicana* have often been included as varieties or subspecies within *S. sempervirens* (e.g., Cronquist 1968; Semple & Cook 2006). Semple (2012; 2016 frequently updated) treated all three taxa as separate species. Schaefer (2015) reported that plants of *S. azorica* from the Azores differed in their nuclear ITS and ETS sequences plus a number of microsatellite markers from plants of *S. sempervirens* from North America. He also noted that historical records indicated that *S. azorica* was likely present in the Azores in pre-Columbian times with birds being the likely means of the original dispersal from North America in the past. *Solidago maya* is native to the highlands of Chiapas, Mexico, in eastern Guatemala, and central Belize; this species is described in the sister paper to this publication (Semple 2016).

Specimens of *Solidago mexicana* have been confused with *S. virgata* Michx., which is here treated as a member of the *S. stricta* Ait. (sensu Semple 2013) complex of species including, *S. austrina* Small, *S. chrysopsis* Small, *S. gracillima* Torr. & A. Gray, and *S. pulchra* Small. Application of the name *S. stricta* has varied since it was published in 1789; critical for this publication is the misapplication of the name to plants native to the southeastern USA and Mexico (Fernald 1950; Cronquist 1968, 1980; Bell et

al. 1968; Correll & Johnston 1970; Nash 1976; McVaugh 1984; Jones & Coile 1988; Semple & Cook 2006; Semple 2012). Other species in the *S. stricta* complex are not dealt with further in this publication. A manuscript on a multivariate analysis of the *S. stricta* complex is in preparation. A multivariate analysis of the remaining small *S. uliginosa* complex of *S.* subsect. *Maritimae* is also nearing completion; this will deal with whether or not the complex can be usefully split into two or three species based on ploidy differences and geographic range differences.

Within *Solidago mexicana*, the western populations from Louisiana to south Texas are tetraploid (Semple et al. 1993, reported as *S. stricta*; additional unpublished reports), while populations further east and north along the Gulf and Atlantic coasts are all diploid (Beaudry 1963; Semple et al. 1984, 1992, 1993; unpublished counts). Because the literature (e.g. Correll & Johnston 1970) and field experience and herbarium sheet examination by the first author indicated that in coastal Texas it was difficult to separate *S. stricta* (sensu authors not Aiton) from *S. sempervirens* var. *mexicana* (= *S. mexicana*), the possibility that the tetraploids were a separate allopolyploid race derived from hybridization of diploid *S. mexicana* and diploids of *S. virgata* in Louisiana was considered by the first author for a number of years. All chromosome count reports for *S. sempervirens* and *S. azorica* are diploid (Beaudry & Chabot 1959; Beaudry 1963; Kapoor 1970; Kovanda 1972; Morton 1981; Semple et al. 1984; 1992, 1993; additional unpublished counts). Thus, the only known tetraploids in the *S. sempervirens* complex occur in the western part of the range from Louisana to south Texas (no reports are known from Mexico). In contrast, polyploidy occurs in multiple species in the *S. stricta* complex.

A multivariate morphometric analysis of the *Solidago sempervirens* complex has not been previously published. Such a study is presented below in order to statistically access the following questions: (1) how significant are the differences between *S. azorica*, *S. mexicana*, and *S. sempervirens* and which characters best distinguish the taxa; (2) whether *S. mexicana* could be usefully divided into eastern and western taxa; (3) whether or not the plants in the complex from the Mexican,Guatemalan, and Belize highlands (*S. maya*) differ significantly enough from *S. mexicana* and *S. virgata* to warrant being placed in a new species and is that new species more similar to *S. mexicana* (eastern and western populations separately or combined) or *S. virgata*; and (4) how different is *S. paniculata* from other species in the complex?

MATERIALS AND METHODS

In total, 119 specimens selected from much larger numbers of specimen from AZU, BM, F, FSU, GH, J.K.Morton personal herbarium in ROM, LL, MEXU, MO, NCU, NY, TEX, USF, and WAT in MT (Thiers, continuously updated) were scored and included in the analysis. Data on *Solidago azorica* (18 specimens; Fig. 1), *S. maya* (9 specimens; Fig. 2), *S. mexicana* (44 specimens; 28 eastern and 16 western; Fig. 3), *S. paniculata* (9 specimens; Fig. 4), *S. sempervirens* (16 specimens; Fig. 5) of the *S. sempervirens* complex, and *S. virgata* (26 specimens) of the *S. stricta* complex were included. Ranges of species in the *S. sempervirens* complex are shown in Fig. 6 along with the locations of samples included in the multivariate analysis. Nineteen vegetative and 19 floral traits were scored when possible: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait.

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics were used to define a priori groups along with geographic location. Basal rosette and lower stem leaf traits were not included in the analyses because these were often not present on specimens. No lower stem and rosette leaves were observed on any collections of *Solidago paniculata*, although petiole base scars indicate that the petioles sheathed the lower stem as in other species in the complex.

All analyses were performed using SYSTAT v.10 (SPSS 2000). A pair-wise Pearson correlation matrix was created to determine which characters were highly correlated. One trait of each pair that had r > |0.7| correlation value was excluded from the analysis to avoid possible pleiotropic effects of a single gene and to make the tests of null hypotheses more stringent. Stepwise discriminant analysis (STEPDISC) was used to select traits that best separated groups based on the Mahalanobis distances between a priori group centroids in N-dimensional hyperspace. Classificatory discriminant analysis was run on N-1 traits selected by the STEPDISC analysis. If more than N-1 traits were selected, where N = lowest sample size of the a priori groups; in this study N=9 (*Solidago maya* and *S. paniculata*). A COMPLETE analysis would then be run using only eight traits. Geisser probabilities of assignment to each a priori group were generated a posteriori for each specimen based on the Mahalanobis distances from the specimen location plotted in N-dimensional hyperspace to each a priori group centroid. Linear and Jackknifed analyses were run in each classificatory analysis to test the strength of group separation in terms of the numbers of discriminating traits. Results are presented in the form of (1) F-value matrices based on Mahalanobis distances between group centroids and (2) tables summarizing the results of the two methods of doing the classificatory discriminant analyses. Conclusions were reached based on the percents of correct placements of specimens and the probabilities of the placements being correct and visual re-examination of each specimen via high resolution digital images or the specimens. Lastly, a canonical analysis was performed as a dimension reduction technique to allow visualization of results in 1 to 3 dimensions with the number of dimensions being N-1, where in this case N equals the number of a priori groups in an analysis. While canonical analysis allows for a visual presentation of results, the plots are based on fewer axes than are used in the statistical analyses and thus do not fully show the multi-dimensional nature of the separation of a priori groups.

Nine analyses were performed that are reported here. Many preliminary analyses were run on smaller data bases over multiple years as additional specimens and taxa were added to the matrix. The first analysis included specimens of six species level a priori groups: *S. azorica*, *S. maya*, *S. mexicana* (eastern populations, diploid when known), *S. mexicana* (western populations, tetraploid when known), *S. paniculata*, and *S. sempervirens* (including only plants that had been treated as ssp. or var. *sempervirens*). The second analysis included five species level a priori groups: *S. azorica*, *S. maya*, *S. mexicana* (eastern and western populations), *S. paniculata*, and *S. sempervirens*. The third analysis included four species: *S. azorica*, *S. maya*, *S. mexicana* (all populations), and *S. sempervirens*. The fourth analysis included four species level a priori groups: *S. maya*, *S. mexicana* (diploid eastern populations), *S. mexicana* (tetraploid western populations), and *S. virgata* (including diploid, tetraploid, and hexaploid plants when known). The fifth analysis included three species level a priori groups: *S. maya*, *S. mexicana* (eastern and western populations combined), and *S. virgata*. The sixth analysis included three species level a priori groups: *S. azorica*, *S. mexicana* (eastern and western populations combined), and *S. sempervirens*. The seventh analysis included two species level a priori groups: *S. mexicana* (eastern and western populations combined) and *S. sempervirens*. The eighth analysis included two species level a priori groups: *S. maya* and *S. virgata*. The ninth analysis included two species level a priori groups: *S. maya* and *S. mexicana* (western populations only). The number of specimens in a group varied due to absence of some data.

RESULTS

The Pearson correlation matrix yielded r > |0.7| for most pairs of leaf treats reducing the number to be used to either mid leaf length and upper leaf width or mid leaf width and upper leaf length. Lower leaves were often absent and were not included in the discriminant analyses. Both combinations of mid and upper leaf traits were used in preliminary analyses with the more discriminating results being present below. Overall, leaf blade shape is similar in all species and size differences between lower and upper stem leaves varies among and sometimes within species. Lower stem leaves lacked serrations in all cases and were very rarely present in very low numbers on basal rosette leaves.

Figure 1. Example of *Solidago azorica* used in the multivariate study: *Anon. 1277* AZU.

Figure 2. Example of *Solidago maya* used in the multivariate study: *Breedlove 27763* F.

UNIVERSITY OF
SOUTH FLORIDA
HERBARIUM
253702
Solidago mexicana L.
Det. J. C. Semple 2011
WAT University of Waterloo
Multivariate Studies in Solidago
Solidago subsect. Maritimae
Y-F Bai & J.C. Semple Specimen No 203
WAT University of Waterloo
PLANTS OF FLORIDA
Solidago sempervirens L.
VOLUSIA CO.:Tomoka State Park; Johns Island;
ca. 1 km E. of the US 1 bridge at the Tomoka River,
ca. 1 km NNE of the N terminus of Nova Rd. (CR 5A)
29° 18' 2.0" N, 81° 05' 12.7" W
raised unpaved service road traversing brackish marsh.
John M. Kunzer #1207
22 October 2005
UNIVERSITY OF SOUTH FLORIDA HERBARIUM

Figure 3. Example of *Solidago mexicana* used in the multivariate study: *Kunzer 1207* USF.

Figure 4. Example of *Solidago paniculata* used in the multivariate study: *MacDaniels 611* F.

Figure 5. Example of *Solidago sempervirens* used in the multivariate study: *Semple & Keir 4814* WAT ex JCSemple.

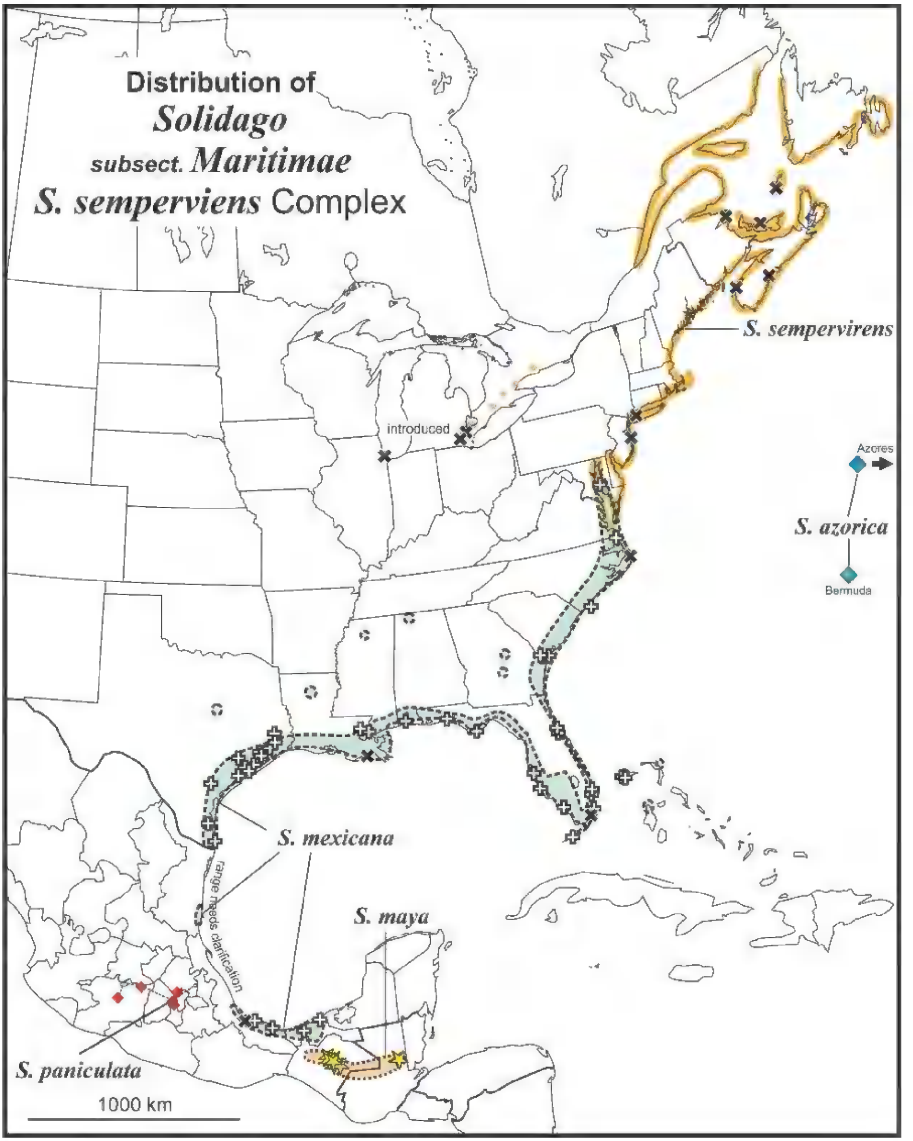

Figure 6. Distribution of the ranges and locations of multivariate samples of the species of the *Solidago sempervirens* complex (*Solidago* subsect. *Maritimae*): *S. azorica*, blue diamonds; *S. maya*, yellow stars; *S. mexicana*, white +s; *S. paniculata*, red diamonds; *S. sempervirens* s.s., black ×s. Symbols indicate a priori group assignments; in a few cases final identification to species of some specimens in the area of range sympatry of *S. sempervirens* and *S. mexicana* in North Carolina to Maryland was difficult.

Table 1. Traits scored for the multivariate analyses of specimens of *Solidago azorica*, *S. maya*, *S. mexicana*, *S. paniculata*, *S. sempervirens*, and *S. virgata*.

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
UPSTMNOD25	Number of nodes in distal 25% of the stem below the inflorescence
UPSTMNOD 20	Number of nodes in distal 20% of the stem below the inflorescence
BLFLN	Basal rosette leaf length measured from the leaf base to tip (mm)
BLFWD	Basal rosette leaf width measured at the widest point (mm)
BLFWTOE	Basal rosette leaf measured from the widest point to the end (mm)
BLFSER	Basal rosette leaf dentation - number of serrations along (one side)
LLFLN	Lower leaf length measured from the leaf base to tip (mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end (mm)
LLFSER	Lower leaf margin - number of serrations (one side)
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf margin - number of serrations (one side)
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end (mm)
ULFSER	Upper leaf margin - number of serrations (one side)
CAPL	Length of inflorescence (cm)
CAPW	Width of inflorescence (cm)
CAPBRLN	Length of longest lower inflorescence branches (cm)
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
OPHYLW	Outer phyllary width (mm)
IPHYLN	Inner phyllary length (mm)
IPHYLW	Inner phyllary width (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
RPUB	Density of hairs on ray floret ovary at anthesis (1-5 scale)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)
DPUB	Density of hairs on disc floret ovary at anthesis (1-5 scale)

Six species groups analysis

In the STEPWISE discriminant analysis of six species level a priori groups *Solidago azorica*, *S. maya*, *S. mexicana* eastern (mostly or entirely diploids), *S. mexicana* western (mostly or entirely tetraploids), *S. paniculata*, and *S. sempervirens*, the following five traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: mid leaf width (27.31), number of ray florets (20.00), number of leaf nodes in the distal 25% of the stem below the inflorescence (9.38), involucre height (9.14), and number of disc florets (8.34). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *Solidago azorica* and western *S. mexicana* (28.828), *S. azorica* and *S. paniculata* (25.972), *S. paniculata* and *S. sempervirens* (21.985), and *S. paniculata* and western *S. mexicana* (21.253), and the least separation was between *S. maya* and eastern *S. mexicana* (1.082).

In the a posteriori Classificatory Discriminant Analysis of the six species level a priori groups, a posteriori assignments of specimens ranged from 39-94% to their own group. The Classification matrix and Jackknife classification matrix are presented in Table 3. Results are presented in decreasing order of percent correct placement. Seventeen of 18 specimens of *S. azorica* (94%) were assigned a posteriori to the *S. azorica* group; 11 with 93-100% probabilities, 3 with 81-84% probability, 1 from Bermuda with 63% probability (29% to eastern *S. mexicana* and 7% to *S. maya*), and 1 specimens from Bermuda with53% probability (36% to eastern *S. mexicana* and 9% to *S. maya*). One cultivated specimen from N. Bimini, Bahamas (*R. & E. Howard 10104*, NY) included in the *S. azorica* a priori group was placed a posteriori into the eastern *S. mexicana* group with 42% probability (40% to *S. maya*, 17% to *S. azorica*).

Table 2. Between groups F-matrix for the six a priori group analysis (df = 5 80).

Group	*azorica*	*maya*	*mexicana*E	*mexicana*W	*paniculata*
maya	14.463				
***mexicana*E**	18.901	1.082			
***mexicana*W**	28.828	6.454	6.454		
paniculata	25.972	17.406	19.139	21.253	
sempervirens	19.052	15.912	18.252	15.057	21.985

Wilks' lambda = 0.0437 df = 5 5 84
Approx. F = 15.7684 df = 25 298 prob = 0.0000

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of six a priori groups; a posteriori placements to groups in rows.

Group	*azorica*	*maya*	*mexicana* E	*mexicana* W	*paniculata*	*sempervirens*	% correct
azorica	17	0	1	0	0	0	94
maya	0	6	3	0	0	0	67
***mexicana* E**	1	8	8	4	0	2	39
***mexicana* W**	0	1	4	10	0	1	63
paniculata	0	0	2	0	7	0	78
sempervirens	1	1	0	1	0	12	80
Totals	19	15	19	15	7	15	68

Jackknifed classification matrix

Group	*azorica*	*maya*	*mexicana* E	*mexicana* W	*paniculata*	*sempervirens*	% correct
azorica	17	0	1	0	0	0	94
maya	0	6	3	0	0	0	56
***mexicana* E**	1	7	9	4	0	2	35
***mexicana* W**	0	1	4	9	0	2	56
paniculata	0	0	2	0	7	0	78
sempervirens	1	1	0	1	0	12	80
Totals	19	15	19	15	7	15	64

Twelve of 15 specimens of *S. sempervirens* (80%) plus one additional specimen not included in the a priori group were placed a posteriori into the *S. sempervirens* group: 9 specimens were placed a posterior with 91-100% probability; 1 specimen from Louisiana (*Morton & Venn NA6942*, WAT) with 72% probability (19% to western *S. mexicana*, and 7% to eastern *S. mexicana*); 1 specimen from Veracruz, Mexico (*Nee & Taylor*, *29186* F), with 60% probability (28% to *S. azorica*, 10% to eastern *S. mexicana*, and 1% to western *S. mexicana*); and 1 specimen from New Brunswick (*J. & B. Semple*, *11453* WAT) with 48% probability (20% to *S. azorica*, 16% to western *S. mexicana*, and 2% to eastern *S. mexicana*). Four specimens of the *S. sempervirens* a priori group were placed a posteriori into other taxa: 1 specimen from Veracruz, Mexico (*Nee & Taylor 29186*, TEX) was placed into *S. azorica* with 98% probability; 1 specimen adventive in southeastern Michigan (*Semple & Suripto 9466*, WAT) was placed a posteriori into *S. maya* with 42% probability (41% to eastern *S. mexicana*, 7% to western *S. mexicana*, and 5% to *S. azorica* and *S. sempervirens*); 1 specimen from Dare Co., North Carolina (*Qualls*, *1252* NCU) was placed a posteriori into eastern *S. mexicana* with 43% probability (28% to *S. maya*, 22% to western *S. mexicana*, and 4% to *S. sempervirens*); and 1 specimen from Dade Co., Florida (*Lakela*, *26882* USF) was placed a posteriori into western *S. mexicana* with 56% probability (30% to eastern *S. mexicana*, 9% to *S. sempervirens*, and 4% to *S. maya*). Seven of the 9 specimens of *S. paniculata* (78%) were assigned a posteriori to the *S. paniculata* group with 91-100% probability. Two specimens were assigned a posteriori into eastern *S. mexicana* with 52% probability (20% to *S. maya*, 16% to western *S. mexicana*, and 8% to *S. paniculata*) and 51% probability (25% to *S. paniculata*, 17% to *S. maya* and 3% to western *S. mexicana*). Six of the 9 specimens of the *S. maya* a priori group (67%) were assigned a posteriori to *the S. maya* group with 42-78% probability (19-40% to eastern *S. mexicana*, and 1-17% to western *S. mexicana*). Two specimens of the *S. maya* a priori group were assigned a posteriori to the eastern *S. mexicana* group with 45% and 52% probabilities (44% and 40% to *S. maya*, respectively). Ten of 16 specimens of the western *S. mexicana* a priori group (63%) were assigned a posteriori to the western *S. mexicana* group: 5 with 97-100%, 1 with 60% (31% to eastern *S. mexicana* and 8% to *S. maya*), and 3 with 44-50% (18-34% to *S. maya* and 12-32% to eastern *S. mexicana*). Six specimens of the western *S. mexicana* group were assigned a posteriori to other groups: 1 to *S. azorica* with 75% probability (24% to western *S. mexicana*); 1 to *S. maya* with 40% probability (34% to western *S. mexicana*, 26% to eastern *S. mexicana*); and 4 to eastern *S. mexicana* with 37-55% probability (2-36% to western *S. mexicana* and 20-45% to *S. maya*). Nine of the 23 specimens of the eastern *S. mexicana* a priori group (39%) were assigned a posteriori to the eastern *S. mexicana* group: 5 with 59-68% probability (31-46% to *S. maya*), 1 with 52% probability (46% to *S. maya*), and 3 with 41-45% probability (1 with 26% to *S. sempervirens*, 19% to western *S. mexicana*, and 13% to *S. maya*; 2 with 31-34% to *S. maya* and 21-23% to western *S. mexicana*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago azorica*, *S. maya*, *S. mexicana* eastern and western separately, *S. paniculata*, and *S. sempervirens* are presented in Fig. 7. Eigen values on the first three axes were 2.049, 1.521 and 1.321.

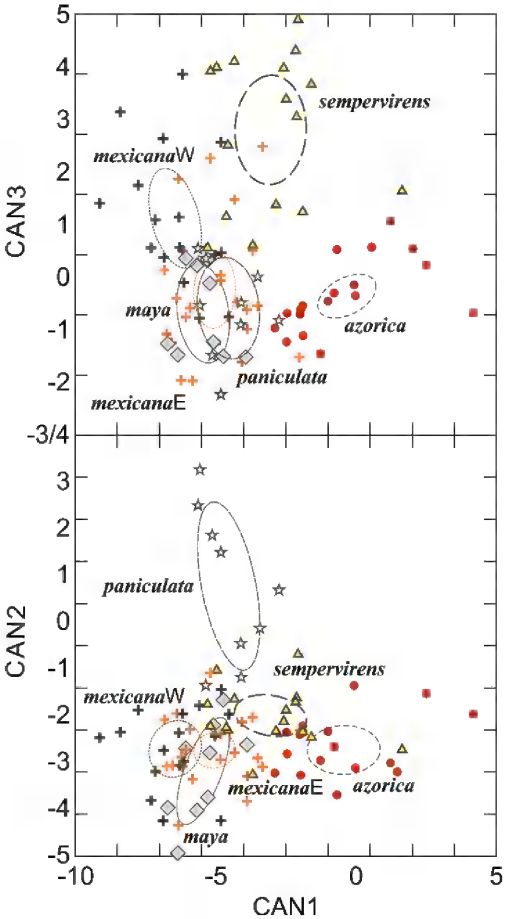

Figure 7. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 canonical scores for 90 specimens of six a priori groups of the *Solidago sempervirens* complex: *S. azorica* (red dots), *S. maya* (gray diamonds), *S. mexicana* divided into eastern (orange +) and western (black +) groups, *S. paniculata* (white stars), *S. sempervirens* (yellow triangles).

Five species groups analysis

In the STEPWISE discriminant analysis of five species level a priori groups (*Solidago azorica*, *S. maya*, *S. mexicana* eastern and western combined, *S. paniculata*, and *S. sempervirens*), the following six traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of ray florets (18.98), involucre height (12.83), mid leaf width (12.61), number of disc florets (9.16), upper leaf length (6.61), and number of nodes in distal 25% of the stem below the inflorescence (4.15). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the

discriminant analysis is presented in Table 4. F-values based on Mahalanobis distances of the between group centroids indicated the largest separations were between *Solidago azorica* and *S. paniculata* (22.792), *S. mexicana* and *S. paniculata* (22.733), and *S. azorica* and *S. mexicana* (22.611); the smallest separation was between *S. maya* and *S. mexicana* (1.973).

Table 4. Between groups F-matrix for the five a priori group analysis (df = 6 80).

Group	*azorica*	*maya*	*mexicana*	*paniculata*
maya	12.654			
mexicana	22.611	1.973		
paniculata	22.792	17.857	22.733	
sempervirens	14.991	15.604	20.182	18.149

Wilks' lambda = 0.0502 df = 6 4 85
Approx. F= 15.8369 df = 24 280 prob = 0.0000

In the Classificatory Discriminant Analysis of the five species level a priori groups, percents of correct a posterori assignment to the same a priori group ranged from 100% down to 51%. The Classification matrix and Jackknife classification matrix are presented in Table 5. Results are presented in order of decreasing percents of correct placement. All 9 specimens of *S. maya* (100%) were assigned a posteriori into the *S. maya* group; 2 with 87% and 83% probabilities, 2 with 77% and 72% probabilities, 3 with 60-67% probability, and two with 56% and 52% probabilities; all lower probabilities were to *S. mexicana* (eastern and western combined). Seventeen of the 18 specimens of *S. azorica* (94%) were assigned a posteriori into the *S. azorica* group; 13 with 90-100% % probability, 2 with 83% and 81% probabilities, 1 with 70% probability (20% to *S. mexicana* and 10% to *S. maya*), and 1 with 67% probability (16% to *S. mexicana*, 15% to *S. maya*, and 2% to *S. sempervirens*). One specimen of the *S. azorica* a priori group was assigned a posteriori to the *S. maya* group with 43% probability (31% to *S. azorica* and 25% to *S. mexicana*). Eight of the 7 of the 8 specimens of *S. paniculata* (89%; one specimen was excluded) were assigned a posteriori to the *S. paniculata* group; 6 with 98-100% probability and 1 with 86% probability (6% to *S. sempervirens*, 5% to *S. mexicana*, 2% to *S.* azorica, and 1% to *S. maya*). Thirteen of the 16 specimens of *S. sempervirens* (87%) were assigned a posteriori into the *S. sempervirens* group; 10 with 97-100% probability; 1 with 81% probability (18% to *S. azorica*); 1 with 76% probability (18% to *S. mexicana*, 3% to *S. azorica*, 2% to *S. paniculata*, and 1% to *S. maya*); and 1 with 57% probability (34% to *S. azorica* and 8% to *S. mexicana*). Three specimens of the *S. sempervirens* a priori group were assigned a posteriori to other species: 1 to *S. azorica* with 96% probability, 1 to *S. mexicana* group with 51% probability (23% to *S. sempervirens* and 18% to *S. maya*) and 1 to *S. mexicana* with 41% probability (41% to *S. maya* and 10% to *S. azorica*, and 8% to *S. sempervirens*). Twenty of the 39 specimens of the *S. mexicana* (eastern and western combined; 51%;) a priori group were assigned a posteriori into the *S. mexicana* group; 5 with 94-99% probability, 3 with 81-84% probability, 1 with 71% probability (28% to *S. maya*), with 60-67% probability (most lower probabilities to *S. maya*); and 1 with 48% probability (41% to *S. maya* and 10% to *S. sempervirens*). Nineteen specimens of the *S. mexicana* a priori group were assigned a posteriori to other species: 2 to *S. sempervirens* with 90% and 84% probability (6% and 15% to *S. mexicana*, respectively); 1 to *S. azorica* with 77% probability (15% to *S. mexicana* and 8% to *S. maya*); and 14 to *S. maya* with 51-75% probability (nearly all other probabilities to *S. mexicana*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago azorica*, *S. maya*, *S. mexicana* (eastern and western combined), *S. paniculata*, and *S. sempervirens* are presented in Fig. 8. Eigen values on the first three axes were 2.247, 1.719 and 1.064.

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Group	*azorica*	*maya*	*mexicana*	*paniculata*	*sempervirens*	% correct
azorica	17	1	0	0	0	94
maya	0	9	0	0	0	100
mexicana	1	15	20	0	3	51
paniculata	0	0	1	8	0	89
sempervirens	1	0	1	0	13	87
Totals	19	25	22	8	16	74

Jackknifed classification matrix

Group	*azorica*	*maya*	*mexicana*	*paniculata*	*sempervirens*	% correct
azorica	17	1	0	0	0	94
maya	0	7	2	0	0	78
mexicana	1	16	17	0	5	44
paniculata	0	0	1	8	0	89
sempervirens	1	0	1	0	13	87
Totals	19	24	21	8	18	69

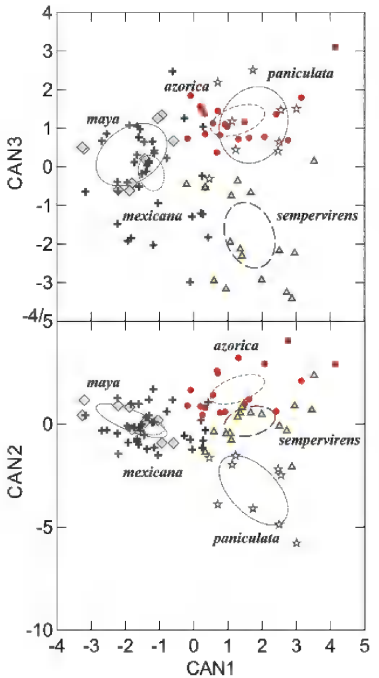

Figure 8. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 canonical scores for 90 specimens of five a priori groups of the *Solidago sempervirens* complex: *S. azorica* (red dots), *S. maya* (gray diamonds), *S. mexicana* (eastern and western combine, black +), *S. paniculata* (white stars), *S. sempervirens* (yellow triangles).

Four species groups analysis I

In the STEPWISE discriminant analysis of four species level a priori groups (*Solidago azorica, S. maya, S. mexicana* eastern and western combined, and *S. sempervirens*), the following seven traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: involucre height (22.63), mid leaf width (10.99), mid series phyllary length (8.29), upper leaf length (7.13), number of leaf nodes in the distal 25% of the stem below the inflorescence (4.37), mid series phyllary width d (4.35), and ray floret ovary length at anthesis (4.06). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 6. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *S. mexicana* and *S. sempervirens* (23.181), and the smallest separation was between *S. maya* and western *S. mexicana* (3.150).

In the Classificatory Discriminant Analysis of the first four species level a priori groups, percents of correct placement a posteriori ranged from 79-100%. The Classification matrix and Jackknife classification matrix are presented in Table 7. All 9 specimens of *S. maya* (100%) were assigned a posteriori to the species; 3 specimens were assigned with 91-96% probability, 2 specimens with 81-84%, 1 specimen with 76% probability, 2 with 67-69%, and 1 specimen with 59% (40% to western *S. mexicana*). All 18 specimens of the *S. azorica* a priori group (100%) were assigned a posteriori into the *S. azorica* group; 11 with 92-100% probability, 3 specimens with 81-85% probability; 2 with 77% probability (14% to *S. mexicana* and 4% to *S. sempervirens*; 15% to *S. maya* and 8% to *S. mexicana*); 1 with 58% probability (29% to *S. maya* and 13% to *S. mexicana*); and 1 with 47% probability 36% to *S. maya* and 17% to *S. mexicana*). Fourteen of the 15 specimens of *S. sempervirens* (93%) were assigned a posteriori into the *S. sempervirens* group; 10 specimens with 90-100% probability; 3 specimens from New Brunswick, Veracruz, and Florida, with 80-85% probability; and 1 specimen from Louisiana, *Morton & Venn NA6942* (WAT), with 52% probability (44% to *S. mexicana* and 3% to *S. azorica*). One specimen of *S. sempervirens* adventive in southeastern Michigan, *Semple & Suripto* 9466 (WAT), was assigned a posteriori to the *S. azorica* group with 40% probability (28% to *S. mexicana*, 18% to *S. sempervirens*, and 18% to *S. maya*). Twenty-eight of the 39 specimens of *S. mexicana* (79%) were assigned a posteriori into the *S. mexicana* group; 7 specimens with 95-100% probability; 7 specimens with 83-88% probability; 11 specimens with 77-79% probability (10 with 21-24% to *S. maya*; 1 with 16 to *S. sempervirens* and 7% to *S. azxorica*); 2 specimens with 61-62% probability (37% to *S. maya*); 3 specimens with 50-56% probability (43-50% to *S.* maya); and 1 specimen with 47% probabilities (44% to *S. maya* and 4% to *S. azorica*). Eight specimens of *S. mexicana* were assigned a posteriori to other species: 7 were assigned to *S. maya* group with 46-84% probability (6 with lower probabilities to *S. mexicana*); and 1 specimen from Texas to *S. sempervirens* with 67% probability (32% to *S. mexicana*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago azorica, S. maya,* western *S. mexicana,* and *S. sempervirens* are presented in Fig. 9. Eigen values on the first three axes were 2.980, 1.235 and 0.254.

Table 6. Between groups F-matrix for the four a priori group analysis (df = 6 72).

Group	*azorica*	*maya*	*mexicana*
maya	12.407		
mexicana	18.790	3.150	
sempervirens	13.122	17.905	23.181

Wilks' lambda = 0.0887 df = 6 3 77
Approx. F= 15.3562 df = 18 204 prob = 0.0000

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of four a priori groups; a posteriori placements to groups in rows.

Group	*azorica*	*maya*	*mexicana*	*sempervirens*	% correct
azorica	18	0	0	0	100
maya	0	9	0	0	100
mexicana	0	7	31	1	79
sempervirens	1	0	0	14	93
Totals	19	16	31	15	89

Jackknifed classification matrix

Group	*azorica*	*maya*	*mexicana*	*sempervirens*	% correct
azorica	16	2	0	0	89
maya	0	9	0	0	100
mexicana	1	9	28	1	72
sempervirens	3	0	1	11	73
Totals	20	20	29	12	79

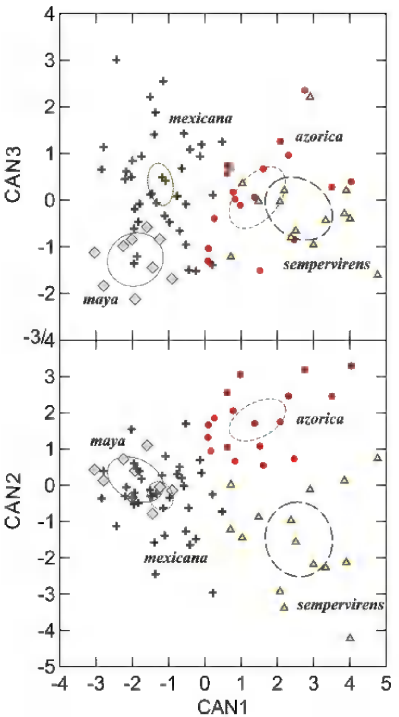

Figure 9. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 81 specimens in four a priori groups of the *Solidago sempervirens* complex: *S. azorica* (red dots), *S. maya* (gray diamonds), *S. mexicana* (eastern and western combined, (black +s) groups, *S. sempervirens* (yellow triangles).

Four species groups analysis II

In the STEPWISE discriminant analysis of the second four species level a priori groups (*Solidago maya*, eastern and western *S. mexicana* separately, and *S. virgata*), the following four traits were selected in a STEPWISE analysis as most strongly separating the four groups and are listed in order of decreasing F-to-remove values: upper leaf length (6.93), disc floret pappus length at anthesis (6.82), number of leaf nodes in the distal 25% of the stem below the inflorescence (6.68), and number of disc florets (5,53). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 8. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between eastern *Solidago mexicana* and *S. virgata* (20.055) and the small separation was between *S. maya* and eastern *S. mexicana* (1.067).

In the Classificatory Discriminant Analysis of the second four species level a priori groups, percents of correct assignment a posteriori ranged from 52% to 81%. The Classification matrix and Jackknife classification matrix are presented in Table 9. Twenty-one of 39 specimens of *S. virgata* (81%) were assigned a posteriori to the *S. virgata* group: 9 specimens with 96-99% probability, 7 specimens with 82-88% probability; 2 specimens with 76-79% probability (17% each to *S. maya*); 1 specimen with 59% (20% to *S. maya*, 17% to eastern *S. mexicana*); 1 specimen with 51% (34% to *S. maya*, 8% to western *S. mexicana*); and 1 specimen with 48% (28% to *S. maya*, 15% to eastern *S. mexicana*, and 9% to western *S. mexicana*). Seven of 9 specimens of *S. maya* (78%) were assigned a posteriori to the *S. maya* group; 3 with 51-57% probability (27-42% to eastern *S. mexicana*, 4-27% to western *S. mexicana* and 3-9% to *S. virgata*); 3 with 42-48% probability (10-27% to eastern *S. mexicana*, 10-27% to western *S. mexicana* and 1-21% to *S. virgata*); and 1 with 39% probability (33% to eastern *S. mexicana*, 25% to western *S. mexicana*, and 3% to *S. virgata*). Two specimens of *S. maya* were assigned a posteriori to eastern *S. mexicana*: 1 with 62% (32% to *S. maya*) and 1 with 45% (32% to *S. maya*, and 23% to western *S. mexicana*). Eleven of 17 specimens of western *S. mexicana* (65%) were assigned a posteriori into the western *S. mexicana* group; 1 with 95% probability; 4 with 80-86% probability; 1 with 70%probability; 1 with 60% probabilities; and 3 with 50-57% probability. Six specimens of western *S. mexicana* group were assigned a posteriori to other species: 3 to eastern *S. mexicana* with 57%, 41% and 40% probabilities (38% to western S. mexicana, 25% and 25% to S. maya; respectively); 2 to *S. maya* with 61% and 43% probabilities (21% and 41% to eastern *S. mexicana*; 10% and 12% to western *S. mexicana*; respectively); and 1 to *S. virgata* with 48% probability (26% to western *S. mexicana*; 19% to eastern *S. mexicana*; and 9% to *S. maya*). Fourteen of the 23 specimens of the eastern *S. mexicana* group (52%) were assigned a posteriori into the eastern *S. mexicana* group; 4 with 70-77%% probability, 3 with 63-68%% probability, 1 with 53% probability, 3 with 43-45% probability, and 3 with 30-39% probability. Thirteen specimens were assigned a posteriori to other species: 6 to western *S. mexicana* with 39-77% probability, 6 to *S. maya* with 43-57% probability, and 1 to *S. virgata* with 88% probability.

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for specimens of *Solidago maya*, eastern and western *S. mexicana* separately, and *S. virgata* are presented in Fig. 10. Eigen values on the first three axes were 1.287, 0.341 and 0.047.

Table 8. Between groups F-matrix for the four a priori group analysis (df = 4 72).

Group	***mexicana*E**	***maya***	***mexicana*W**	***virgata***
***mexicana*E**	0.000			
maya	1.067	0.000		
***mexicana*W**	5.443	0.406	0.000	
virgata	20.055	8.467	14.878	0.000

Wilks' lambda = 0.3113 df = 4 3 75; Approx. F= 8.7779 df = 12 190 prob = 0.0000

Table 9. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of four a priori groups; a posteriori placements to groups in rows.

Group	*maya*	*mexicana*E	*mexicana*W	*virgata*	% correct
maya	7	2	0	0	78
***mexicana* E**	2	14	6	1	78
***mexicana* W**	2	3	11	1	65
virgata	4	1	0	21	81
Totals	15	20	17	23	67

Jackknifed classification matrix

Group	*maya*	*mexicana*E	*mexicana* W	*virgata*	% correct
maya	5	3	1	0	56
***mexicana*E**	7	12	7	1	44
***mexicana*W**	3	3	10	1	59
virgata	4	1	0	21	81
Totals	19	19	18	23	61

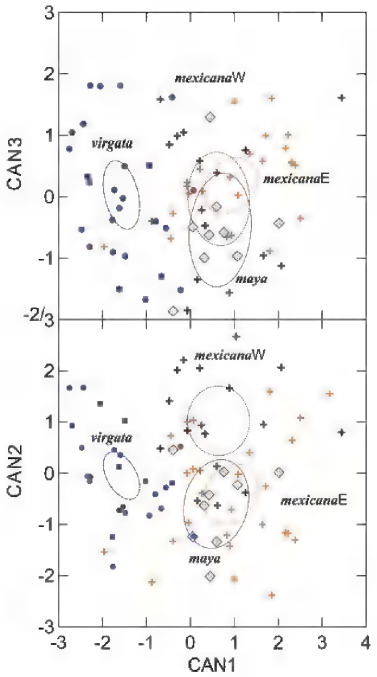

Figure 10. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 79 specimens of four priori groups: *Solidago maya* (gray diamonds), *S. mexicana* is divided into eastern (orange +s) and western (black +s) groups, and *S. virgata* (blue dots).

Three species groups analysis I

In the STEPWISE discriminant analysis of the first three species level a priori groups (*Solidago maya*, *S. mexicana* eastern and western populations combined, and *S. virgata*), the following five traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of ray florets (9.62), upper leaf width (7.03), disc corolla lobe length (6.69), disc floret pappus length at anthesis (5.22), and number of leaf nodes in the distal 25% of the stem below the inflorescence (4.96). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 10. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *Solidago mexicana* and *S. virgata* (19.057), and the small separation was between *S. maya* and *S. mexicana* (2.010).

Table 10. Between groups F-matrix for the three a priori group analysis (df = 5 72).

Group	*maya*	*mexicana*
mexicana	2.010	
virgata	7.372	19.057

Wilks' lambda = 0.37418 df = 5 2 76
Approx. F= 9.1428 df = 10 1442 prob = 0.0000

In the Classificatory Discriminant Analysis of the three species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori group ranged from 64-81%. The Classification matrix and Jackknife classification matrix are presented in Table 11. Twenty-one of the 26 specimens of *S. virgata* (81%) were assigned to that species a posteriori: 14 with 90-100% probability; 3 with 80-89% probability; 3 with 70-71% probability; 1 with 58 (25% to *S. maya* and 18% to *S. mexicana*). Five specimens of *S. virgata* were assigned a posteriori to the *S. maya* group with 43-57% probability (with 19-32% probability to *S. mexicana*). Six of the 9 specimens of the S. maya (67%) a priori group were assigned a posteriori to *S. maya*: 1 with 84; 3 with 75-79%; 1 with 59% (39% to *S. mexicana*); and 1 with 42% (35% to *S. virgata* and 23% to *S. mexicana*). Three specimens of the *S. ma*ya a priori group were assigned to S. mexicana with 64%, 62% and 54% probabilities (35%, 36% and 46% to *S. maya*). Twenty-eight of the 44 specimens of the *S. mexicana* a priori group (64%) were assigned a posteriori to the *S. mexicana* group: 3 with 90-94%; 8 with 84-88%; 5 with 72-78%; 3 with 61-65%; and 9 with 45-57%. Sixteen specimens of the *S. mexicana* a priori group with assigned to other species: 4 to S. virgata with 46-76% probability and 12 to *S. maya* with 44-75% probability.

A two dimensional plot of CAN1 versus CAN2 canonical scores for specimens of *Solidago maya*, *S. mexicana*, and *S. virgata* are presented in Fig. 11. Eigen values on the first two axes were 1.361 and 0.132.

Table 11. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*maya*	*mexicana*	*virgata*	% correct
maya	6	3	0	67
mexicana	12	28	4	64
virgata	5	0	21	81
Totals	23	31	25	70

Jackknifed classification matrix

Group	*maya*	*mexicana*	*virgata*	% correct
maya	5	3	1	56
mexicana	14	24	6	55
virgata	5	0	21	81
Totals	24	27	28	63

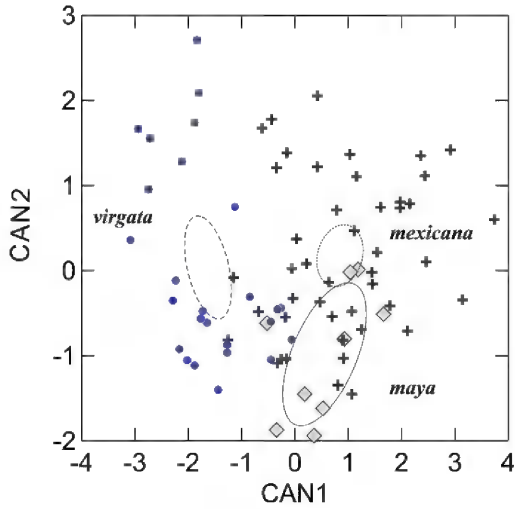

Figure 11. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 79 specimens of two priori groups of the *Solidago sempervirens* complex and a third a priori groups of *S. virgata*: S. mexicana includes eastern and western populations.

Three species groups analysis II

In the STEPWISE discriminant analysis of the second three species level a priori groups (*Solidago azorica*, *S. mexicana* eastern and western combined, and *S. sempervirens*), the following seven traits selected in the STEPWISE analysis are listed in order of decreasing F-to-remove values: involucre height (43.85), upper leaf width (23.20), mid leaf length (13.48), mid series phyllary length (9.81), ray floret pappus length at anthesis (5.57), number of leaf nodes in the distal 25% of the stem below the inflorescence (5.33), and mid series phyllary width at widest point (4.48). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 12. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *Solidago azorica* and *S. mexicana* (24.335), and the smallest separation was between *S. azorica* and *S. sempervirens* (21.948).

In the Classificatory Discriminant Analysis of the three species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori group ranged from 93-100%. The

Classification matrix and Jackknife classification matrix are presented in Table 13. All 18 specimens of *S. azorica* were assigned a posteriori to the *S. azorica* group: 12 specimens were assigned with 98-100% probability; 5 with 91-96% probability; and 1 with 81% probability (16% to *S. sempervirens*). Fifteen of the 16 specimens of *S. sempervirens* (94%) were assigned a posteriori to that species: 11 with 99-100% probability; 1 with 91% probability, 1 with 84% (15% to *S. mexicana*), and 1 with 70% probability (30% to *S. mexicana*). One specimen of *S. sempervirens* was assigned to *S. mexicana* with 77% probability (22% to *S. sempervirens*): the specimen *Semple & Suripto 9466* (WAT) was from an adventive population in southeastern Michigan along Interstate-75. Thirty-nine of the 42 specimens of *S. mexicana* (93%) were assigned a posteriori to the *S. mexicana* group: 36 with 94-100%; 2 with 87-88% probability; and 1 with 70% probability (30 % probability to *S. sempervirens*). Three specimens of *S. mexicana* were assigned a posteriori to *S. sempervirens* with 79%, 64% and 55% probabilities (21%, 36% and 45% to *S. sempervirens*).

A two dimensional plot of CAN1 versus CAN2 canonical scores for specimens of *Solidago azorica*, *S. mexicana* (eastern and western populations combined), and *S. sempervirens* is presented in Fig. 12. Eigen values on the first two axes were 2.559 and 2.252.

Table 12. Between groups F-matrix for the three a priori group analysis (df = 7 67).

Group	*azorica*	*mexicana*
mexicana	24.335	
sempervirens	21.948	22.297

Wilks' lambda = 0.0864 df = 7 2 73; Approx. F= 22.9902 df = 14 134 prob = 0.0000

Table 13. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*azorica*	*mexicana*	*sempervirens*	% correct
azorica	18	0	0	100
mexicana	0	39	3	93
sempervirens	0	1	15	94
Totals	18	40	18	95

Jackknifed classification matrix

Group	*azorica*	*mexicana*	*sempervirens*	% correct
azorica	17	0	1	94
mexicana	0	39	3	93
sempervirens	1	2	13	81
Totals	18	41	17	91

Two species groups analysis I

In the Pearson Correlation matrix of 59 specimens of *Solidago mexicana* and *S. sempervirens*, nearly all leaf traits correlated with some other leaf trait with r >|0.7| resulting in only upper leaf width being included in the analysis. Basal leaves were often absent and were excluded. Not including mid leaf traits allowed one addition specimen of each species to be included in the discriminant analysis.

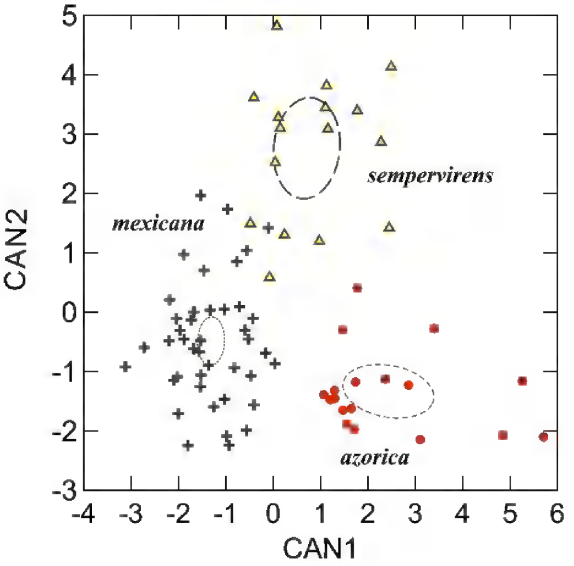

Figure 12. Two dimension plots of CAN1 versus CAN2 for 76 specimens of three a priori groups of the *Solidago sempervirens* complex: *S. azorica* (red dots), *S. mexicana* (eastern and western populations), black +s, *S. sempervirens* (yellow triangles).

In the STEPWISE discriminant analysis of 59 specimens of *Solidago mexicana* and *S. sempervirens*, the following four traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: upper leaf width (63.98), involucre height (47.42), mid series phyllary length (14.56), and number of leaf nodes in the distal 25% of the stem below the inflorescence (4.43). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 14: *S. mexicana* and *S. sempervirens* had an F-to separate value of 34.103.

Table 14. Between groups F-matrix for the three a priori group analysis (df = 4 54).

Group	*mexicana*	*sempervirens*
mexicana	0.0000	
sempervirens	34.104	0.0000

Wilks' lambda = 0.2836 df = 1 57; Approx. F= 34.1030 df = 4 54 prob = 0.0000

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori groups were 95% for *Solidago mexicana* and 88% *S. sempervirens*: two specimens of each species was assigned a posteriori to the other a priori group. The Classification matrix and Jackknife classification matrix are presented in Table 15. Forty-one of the

43 specimens of *S. mexicana* (95%) were assigned a posteriori to that species: 39 specimens with 90-100% probability: 1 specimen from Collier Co., Florida, *Semple 5394* (WAT), with 79% probability, and 1 specimen from Volusia Co., Florida, *Ray et al.* 10851 (USF), with 57% probability. Two species of the *S. mexicana* a priori group were assigned a posteriori to *S. sempervirens* with 86% (Veracruz, Mexico. *Vovides AV-569* F; an incomplete specimen not included in other analyses) and with 61% (Texas. *Semple & Suripto 10079* WAT; 2*n*=36). Fourteen of the 16 specimens of *S. sempervirens* (75%) plus one additional specimen not included in the a priori analysis were assigned a posteriori to the *S. sempervirens* group: 13 specimens with 98-100% probability and 1 specimen from Louisiana, *Morton & Venn NA6942* (WAT), with 60% probability. Three specimens of the *S. sempervirens* a priori group were assigned a posteriori to *S. mexicana*: 1 specimen from Michigan, *Semple & Suripto 9466* (WAT), with 98% probability; 1 specimen from Dare Co., North Carolina, *Qualls* 1252 (NCU), with 88% probability; and 1 specimen from Nova Scotia, *Semple & Keir 4814* (WAT; Fig. 5), with 68% probability.

Frequencies of CAN1 canonical scores for specimens of *S. mexicana* (eastern and western populations combined) and *S. sempervirens* are presented in histograms in Fig. 13. The eigen value on the first axis was 2.526.

Table 15. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*mexicana*	*sempervirens*	% correct
mexicana	41	2	95
sempervirens	2	14	88
Totals	43	16	93

Jackknifed classification matrix

Group	*mexicana*	*sempervirens*	% correct
mexicana	41	2	95
sempervirens	3	13	81
Totals	44	15	92

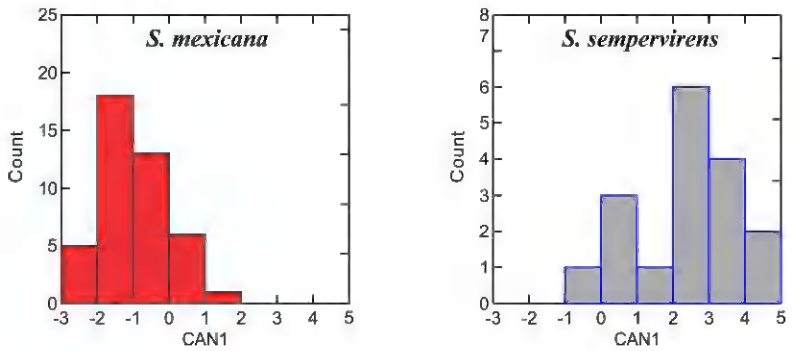

Figure. 13. Histograms of CAN1 canonical scores for 59 specimens of *S. mexicana* (left) and *S. sempervirens* (right).

Two species groups analysis II

In the STEPWISE discriminant analysis of 35 specimens of *Solidago maya* and *S. virgata*, the following two traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: mid leaf length (33.00), involucre height (13.79). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 16: *S. maya* and *S. virgata* had an F-to separate value of 37.540.

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori group were 89% for *S. maya* and 96% *S. virgata*: one specimen of each species was assigned a posteriori to the other a priori group. The Classification matrix and Jackknife classification matrix are presented in Table 17. Seven of the nine specimens of *S. maya* (77.8%) were assigned a posteriori to that species with 98-100% probability: 1 specimens was assigned to *S. maya* with 54% probability; and 1 specimen was assigned a posteriori to *S. virgata* with 73% probability. Twenty-three of the 26 specimens of *S. virgata* (75%) were assigned a posteriori to the *S. virgata* group with 97-100% probability: two specimens plus one additional specimen excluded from the STEPWISE analysis were assigned a posteriori to the *S. virgata* group with 91%, 69% and 67% probabilities; and one specimen was assigned a posteriori to *S. maya* with 85% probability.

Frequencies of CAN1 canonical scores for specimens of *Solidago maya* and *S. virgata* are presented in histograms in Fig. 14. The eigen value on the first two axis was 2.346.

Table 16. Between groups F-matrix for the three a priori group analysis (df = 2 32).

Group	*maya*	*virgata*
maya	0.0000	
virgata	37.5398	0.0000

Wilks' lambda = 0.29888 df = 2 1 33; Approx. F= 37.5398 df = 2 32 prob = 0.0000

Table 17. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*maya*	*virgata*	% correct
maya	8	1	78
virgata	1	25	92
Totals	10	26	94

Jackknifed classification matrix

Group	*maya*	*virgata*	% correct
maya	7	2	78
virgata	2	24	96
Totals	9	26	89

Two species groups analysis III

In the STEPWISE discriminant analysis of 25 specimens of *S. maya* and *S. mexicana* (western populations only), the following four traits were used in a STEPWISE analysis are listed in order of decreasing F-to-remove values: length of ray floret ovary at anthesis (14.62), mid leaf length (8.29), number of nodes in distal 25% of the stem below the inflorescence (7.91), and mid series phyllary width

(6.74). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.001 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 16: *S. maya* and western *S. mexicana* had an F-to separate value of 10.767.

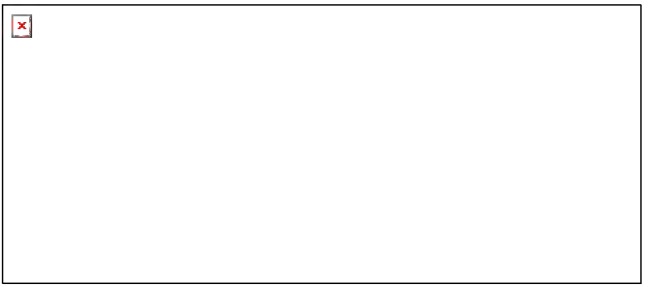

Figure. 14. Histograms of CAN1 canonical scores for 35 specimens of *S. maya* (left) and *S. virgata* (right).

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori group were 100% for both *S. maya* and western *S. mexicana*. The Classification matrix and Jackknife classification matrix are presented in Table 17. Six of the nine specimens of *S. maya* (66.7%) were assigned to that species a posteriori with 96-100% probability: 3 specimens were assigned to *S. maya* with 87%, 76% and 70% probabilities. Twelve of the 16 specimens of *S. mexicana* (75%) were assigned a posteriori to the *S. mexicana* group with 93-100% probability: three specimens were assigned a posteriori to the *S. mexicana* group with 65%, 54% and 51% probabilities.

Frequencies of CAN1 canonical scores for specimens of *S. maya* and western *S. mexicana* are presented in histograms in Fig. 15. The eigen value on the first axis was 2.153.

Table 16. Between groups F-matrix for the three a priori group analysis (df = 2 32).

Group	*maya*	*mexicana*W
maya	0.0000	
*mexicana*W	10.7666	0.0000

Wilks' lambda = 0.3.1718 df = 4 1 23; Approx. F= 10.7666 df = 4 20 prob = 0.0001

Table 17. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*maya*	*mexicana*W	% correct
maya	9	0	100
*mexicana*W	0	16	100
Totals	9	16	100

Jackknifed classification matrix

Group	*maya*	*mexicana*W	% correct
maya	8	1	89
***mexicana*W**	4	12	75
Totals	12	13	80

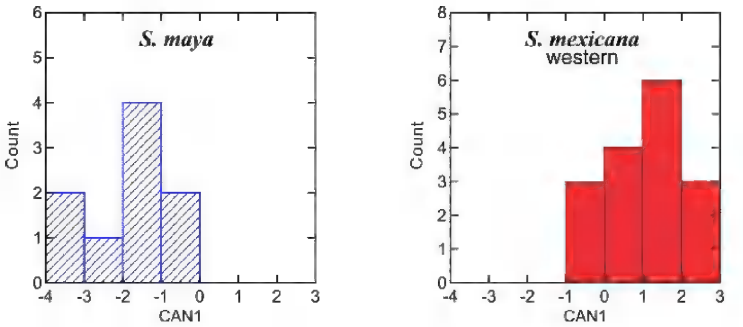

Figure. 15. Histograms of CAN1 canonical scores for 25 specimens of *S. maya* (left) and *S. mexicana* (right; western populations only).

DISCUSSION

The results of the multivariate analyses support the recognition of *Solidago azorica*, *S. maya*, *S. mexicana*, *S. paniculata*, *S. sempervirens*, and *S. virgata* as separate species. The results do not support dividing *S. mexicana* into a diploid eastern and a tetraploid western species at this time; in each analysis where *S. mexicana* was divided into two groups, the percents of correct placement and the probabilities of those placements were relatively low compared to analyses in which *S. mexicana* specimens were not divided into two groups. *Solidago paniculata* from marshes around Mexico City and further west in Michoacán state was strongly separated from most other species in the *S. sempervirens* complex. A single specimen of *S. paniculata* was weakly assigned to *S. mexicana* (all specimens) in one analysis.

The strong results for treating *Solidago azorica* as a separate species are indicated by the large F-to-separate values between *S. azorica* and other species and the high percents of specimens assigned a posteriori to the *S. azorica group*. Thus, the morphological results are in agreement with Schaefer's (2015) molecular results indicating that *S. azorica* and *S. sempervirens* are sufficiently different to warrant treating them as separate species. Plants of *S. azorica* from Bermuda are more likely to be confused with plants of *S. mexicana* and *S. sempervirens* than those from the Azores based on lower percents of correct placements a posteriori to *S. azorica*. One specimen was not assigned to *S. azorica* in the first two analyses; this was a short garden cultivated collection from the Bahamas that was considered to be a specimen of *S. sempervirens* in early stages of the study and by the collector R.A. Howard. It was assigned a priori to *S. azorica* on the basis of geography and the assumption its source was possibly Bermuda or the Azores. In the third analysis including *S. azorica*, the Howard collection was assigned to *S. azorica* with 81% probability. When *S. azorica* arrived in Bermuda and whether or not is it native or just relatively recently introduced is unknown. Additional molecular work involving *S. azorica* from Bermuda might be informative. Short plants of *S. azorica* and *S. sempervirens* can be difficult to place to species as can specimens of *S. azorica* with narrower upper stem leaves. A very short collection of *S. sempervirens* from the Magdalen Islands, Quebec, located midway between Prince Edward Island and Newfoundland (*Oldham 21146* WAT) was placed into *S. sempervirens* with 100% probability in the first

three analyses indicating that short stature is not necessarily a problem with correct identification of the seaside goldenrods.

Numbers of ray and disc florets have been used to separate *Solidago mexicana* and *S. sempervirens* historically (e.g., Cronquist 1980; Weakley 2015) with *S. mexicana* having 7–11 rays and ca. 10–16 disc florets and *S. sempervirens* having 12–17 rays and ca. 17–22 disc florets (Semple and Cook 2006). Fernald (1950) noted the var. *mexicana* had narrower leaves and that the heads were "slightly smaller", but not the numbers of rays and discs in particular. In the analysis of *S. mexicana* (both eastern and western populations combined) and *S. sempervirens*, STEPDISC selected the following as most useful in separating the two species: upper leaf width, involucre height, mid series phyllary length, and number of leaf nodes in the distal 25% of the stem below the inflorescence. The numbers of ray and disc florets were not found to be as useful in separating the two species. Fernald's choice of narrower leaves is thus a better way to separate the two species than on numbers of florets. However, the mean number of rays and discs do follow the pattern indicated by Cronquist (1980), Semple and Cook (2006), and Weakley (2015) but the ranges overlap considerably. A Maryland plant of *S. mexicana* (*Semple & Ringius 7633* WAT) included in the analysis had the narrower and shorter upper stem leaves of *S. mexicana*, but had some of the highest numbers of ray and disc florets for the species (10-11 rays, 13-16 discs). In our sample, the lowest number of rays for a specimen of *S. sempervirens* was 4 and the lowest number of discs was 8, which was well below the means values. Our conclusion is that plants with the highest numbers of rays and discs are *S. sempervirens*, but the overlap in high end for *S. mexicana* and low end for *S. sempervirens* (ca 10-14 rays and 14-17 discs) reduces the traits to secondary characters in distinguishing the two species.

Confusion in separating *Solidago mexicana*, *S. sempervirens*, and *S. virgata* is understandable and complicated by multiple ploidy levels known in *S. mexicana* (2x, 4x) and *S. virgata* (2x, 4x, 6x). However, in those analyses including *S. virgata*, specimens of *S. virgata* were generally more strongly separated from the other species based on F-to-separate matrix values and in having the highest percents of correct placement a posteriori. Western populations of *S. mexicana* were more similar to *S. sempervirens* in some traits (involucre height) than to the eastern populations of *S. mexicana*. This is most likely a consequence of the western being tetraploid plants and the eastern being diploid plants because involucre height is strongly influenced by ploidy level within a species in the genus *Solidago*, e.g., in *Solidago altissima* (Semple et al. 2015). It appears that there are some collections of *S. sempervirens* from areas well into the range of *S. mexicana*; specimens from Louisiana and Mexico really look like *S. sempervirens* overall. These are likely chance adventives introduced by human activity. On the other hand, some of the collections of *S. sempervirens* from introduced populations in the southern Great Lakes region in Michigan and Ontario can have more reduced upper stem leaves than other shoots in the same population. It seems more likely that these are just outlier forms of *S. sempervirens*, then really being long distance disjunct plants of *S. mexicana*. Molecular work might clarify the situation. In some of the analyses, overall typical looking tetraploid specimens of *S. mexicana* were placed in other taxa on technical traits. Only diploid counts are known for *S. sempervirens* and *S. azorica*. It seems unlikely that adventive tetraploid individuals of *S. azorica* or *S. sempervirens* are present along the Gulf coast in Texas. Additional work is needed to determine the origins of the tetraploid populations of *S. mexicana* from Louisana and Texas (are they autopolyploid?) and to determine ploidy levels of *S. mexicana* (and adventive *S. sempervirens*) and *S. maya* from Mexico.

The ecological species concept is particularly useful in dealing with *Solidago* taxa (Peirson et al. 2012). For example, the initial impression of the first author regarding the specimens from Chiapas, Mexico, and Guatemala was that there was no way a species found throughout its entire range from Newfoundland in Canada to along the Gulf coast in Veracruz and Tabasco, Mexico and occurring at 0-30 m elevation could also be growing at 2200 m in Chiapas, Mexico. The strong disjunction in elevation of the habitats suggested that the highland specimens likely belonged in a separate species, which is here and in Semple (2016) treated as the new species *S. maya*. Accumulating data on enough specimens to

statistically demonstrate that *S. maya* and *S. mexicana* were distinct and also not just specimens of *S. sempervirens* s.l. or *S. virgata* took a considerable amount of effort over multiple years. During that time early results of multivariate analyses with fewer specimens and including all species of subsect. *Maritimae* indicated that *S. sempervirens* should be divided and *S. mexicana* should be treated as a separate species. Also, as (1) unpublished results became available supporting splitting the *S. stricta* complex into multiple species (e.g. *S. austrina*, *S. gracillima*, *S. stricta* sensu Ait. not sensu others, e.g. Semple & Cook 2006) that occurred in different habitats, and (2) as unpublished and published results from other subsections of *Solidago* also began to indicate the same problem, it became increasingly obvious that there had been too much lumping of distinct species in *Solidago* by Cronquist (e.g. 1980) and those who followed him (e.g., Semple and Cook 2006). Historically, specimens of *S. maya* have been treated as either belonging in *S. sempervirens* in the broad sense or *S. stricta* in the misapplication-of-the-name sense (*S. virgata* would have been the correct name to use) based on herbarium label and annotation label identifications and the floristic literature covering Chiapas, Mexico and Guatemala (e.g., Nash 1976). The results of the multivariate analyses taken together indicate that *S. maya* should be treated as a separate species but that it is more similar to eastern *S. mexicana* and *S. virgata* than to western *S. mexicana*. No chromosome number has been reported for *S. maya*, but based on involucre height it is more likely to be diploid than tetraploid or hexaploid. Some collections of diploid *S. mexicana* from Florida can be difficult to separate from some *S. maya* and *S. virgata* collections; this is true in the field and with herbarium specimens. Specimens of *S. virgata* always have inflorescences that are narrow with short ascending branches and a non-secund apex. When tall stems (1.5 m plus) arch over from the weight of the inflorescence as it develops, then all branches of the inflorescence can be oriented upward in the field making the entire array secund. Most specimens of *S. mexicana* have inflorescences with longer more spreading lower branches and an erect secund conical shape. Sometimes the apex of the inflorescence is only weakly secund on individual shoots. When the bend in the apex of the inflorescence is flattened out by the angle at which the inflorescence is pressed and dried, then misidentification to *S. virgata* is much more likely. Inflorescences of *S. maya* vary from clearly secund conical in shape to non-secund and narrowly erect like *S. virgata*. If all of *S. mexicana* along the Gulf coast in Mexico is tetraploid as it is in Texas, then the question arises as to what is the origin of putatively diploid *S. maya* in central Mesoamerica. Changes in the distribution of diploid *S. mexicana* and *S. virgata* due to changes in climate associated with glacial advances and retreats during the past 60,000 years may account for the arrival and subsequent isolation and divergence of members of the *S. sempervirens* complex or the *S. stricta* complex in Mesoamerica into the highlands species *S. maya*. Preference for moist soil habitats continued, as this is critical for all species of *S.* subsect. *Maritimae*. The origins of *S. maya* with morphological affinities to relatives in Florida may be similar to the origins of *Pityopsis graminifolia* (Pursh) Nutt. populations disjunct in Guatemala from the eastern Gulf coast and Florida populations of the species (Semple & Bowers 1985; Semple 2006). If there are diploids in *S. mexicana* in Mexico or *S. maya* is found to be tetraploid, then alternative hypotheses on the origins of *S. maya* may be needed.

In conclusion, the *Solidago sempervirens* complex is best treated as a group of five morphologically similar species occurring in wetter soil habitats. Like members of other species complexes in *Solidago*, some difficulty in identifying some collections to species is to be expected. While the multivariate analyses reported here have led to a much better understanding of the complex, they do not provide a 100% fool proof solution to the challenges of identifying goldenrods in the complex.

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NY, TEX, USF, and WAT in MT. The following students assisted in recording location data and collecting morphological data on specimens of *Solidago*: Andrew Lam, Mariam Sorour, and Lan Tong.

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Erratum:
The following reference cited in text was inadvertently omitted from the Literature Cited in the original posting:

Schaefer, H. 2015. On the origin and systematic position of the Azorean goldenrod, *Solidago azorica* (Asteraceae). Phytotaxa 210: 047–059.

Mansfield, D.H., M. Stevens, L. Polito, J.F. Smith, and M. Darrach. 2016. *Lomatium basalticum* (Apiaceae), a new species from the vicinity of Hells Canyon in Oregon and Idaho. Phytoneuron 2016-74: 1–13. Published 29 November 2016. ISSN 2153 733X

LOMATIUM BASALTICUM (APIACEAE), A NEW SPECIES FROM THE VICINITY OF HELLS CANYON IN OREGON AND IDAHO

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ABSTRACT

Lomatium basalticum Mansfield & M. Stevens, **sp. nov.**, is a narrowly endemic species growing on gravelly meadows and open, xeric, rocky slopes in forest openings on weathered basalt flow entablatures on both the Idaho and Oregon sides of Hells Canyon. The species is most closely related to *L. brunsfeldianum* based on strong support from sequence data from 6 genes; and it is vegetatively very similar to the nearby northern Idaho endemic, *L. brunsfeldianum*. The two species can be distinguished geographically, ecologically and by a combination of characters including fruit length, width, and thickness, leaf sheath width, and foliage vestiture.

In recent years a number of new species and subtaxa in *Lomatium* have been described and supported owing to recent field exploration, morphological analysis and genetic sequencing studies, including *L. ochocense* Helliwell (2010), *L. bentonitum* Carlson & Mansfield (Carlson et al. 2011), *L. pastorale* Darrach & Wagner (2012), *L. brunsfeldianum* McNeill (2012), *L. tarantuloides* Darrach & Hinchliff (2014), *L. knokei* Darrach (2014), and *L. swingerae* McNeill (2014).

During the combined Idaho and Washington Botanical Collection Forays in June 2011, collections were made in Adams Co., Idaho, of a species similar to both *Lomatium brunsfeldianum* and *L. grayi*. Subsequent collections over the next five years provided sufficient materials to distinguish among these species. We are now aware of several populations from both the Idaho and Oregon sides of Hells Canyon and are able to distinguish the species morphologically, ecologically, and genetically from *L. brunsfeldianum* and *L. grayi*.

Lomatium basalticum Mansfield and M. Stevens, **sp. nov.** Figures 1–5. TYPE: **USA. Oregon.** Wallowa Co.: Hells Canyon National Recreation Area, 1.26 km SE of McGraw Lookout, 370 m due E of Forest Service Road 110, 45.1672124° N -116.7681258° W, sparse *Pseudoroegneria spicata* grassland/forbland, common on silty loam derived from weathered entablature basalt, southerly aspect, with *Pseudoroegneria spicata, Poa secunda, Bromus carinatus, Sedum stenopetalum, Astragalus reventus, Artemisia rigida*, elev. 1804 m (5920 ft), 5 Jul 2015, *M. Darrach* 1115 (holotype: CIC; isotypes: NY, OSC, RM, WTU, ID).

Lomatium basaliticum can be distinguished from all other recognized members of the genus by the following combination of characters: root narrowly taprooted and often with 2–3 branches, older leaf sheaths neither shredding nor persistent atop a caudex, plants glabrous in the lower parts, leaf sheaths wide (12–20 mm), leaf blades highly dissected into quaternary divisions with ultimate segments of 4–5 mm x <0.5 mm, fruits 13–20 mm x 3–5 mm and at least 1.2 mm thick with wings as thick as the fruit body, 0.6–0.9 mm wide.

Herbs: (Fig. 1) perennial, short-lived, non-aromatic, glabrous except in the umbel rays, caulescent, 35–60 cm in height with typical plants approximately 50 cm in height when in mature fruit. **Root:** typically specimens have non-tuberous taproots (2–4 mm thick) that can be +/- branched bearing 1–3(5) separate taproot-like dvisions (Fig. 2). **Stems:** from a short, reduced caudex, rarely bearing many old leaf scars; 3–8 mm thick, previous years' sheaths never disintegrating into a thatch. **Basal leaves:** ±old sheathing leaf bases, basal leaves 1–4, typically 2, glabrous, compound, 18–30 cm in length, ternate-pinnate and pinnately dissected into quaternary divisions, ultimate segments linear, terete, 4–5 mm X <0.5 mm, basal-most pinnules of tertiary leaflets originating close (<2 mm) to rachis appearing, or nearly, sessile. Petioles of basal leaves 6–14.5 cm long with dark brown sheathing basal portions, 13–17 mm wide. **Cauline leaves:** 1, glabrous, compound, 13–19 cm in length, pinnately dissected into quaternary divisions, ultimate segments 4–5 mm X <0.5 mm, ultimate pinnules nearly sessile. Petioles of cauline leaves 4–6.5 cm with sheathing basal portions. Fresh leaves filling three dimension, never planar (Fig. 3). Pressed leaves usually about equally as long as wide, the leaf outline quadrate, rhombic, or triangular. **Inflorescences:** (Fig. 4) compound, involucre lacking, peduncles strongly ascending to erect, terete. Peduncle 23–41 cm. Rays 6–15, unequal in length in flower, grossly so in fruit, glabrous to sparsely puberulent with short, triangular hairs. Ray length per inflorescence in fruit 4–10 cm. **Involucel:** bractlets typically absent, rarely up to 2 and linear, 3–4 mm. **Flowers:** primarily polygamo-monoecious, flowers glabrous 6–35 per umbellet, many aborting, petals yellow, 0.8–1.4 mm X 0.5–0.8 mm, obovate and obtuse, sometimes with an apiculus; stamens 5 and alternating with the 5 petals, anthers yellow to pale yellow, 0.4–0.6 mm X 0.2–0.4 mm, pollen yellow. Stylopodia greenish. Styles laterally flattened, 1.2–1.5 mm, strongly curved, outwardly divergent; ovaries green and glabrous. **Fruit:** (Figs. 5 and 6) hemispherically arranged with 0–25 fruits per umbellet, typically 6–10, pedicels spreading-ascending to semi-erect, 5.0–10.0 mm, typically 6–8 mm. Fruits glabrous, 12.0–20.3 mm X 3.0–4.8 mm. Fruit wing width 0.6–0.9 mm, about as thickened as the fruit body. Fruit aspect (length/width) ratio 3.4–5.6. Fruit shape elliptical dark brown in the intervals. Dorsal fruit surfaces with typically 3 well-developed nerves slightly elevated above the fruit surface; vittae obscure, 4–7 in the intervals, 1–3 along the commisure. **Carpophore:** cleft nearly to the base, persistent.

Additional specimens examined. Idaho. Adams Co.: Snake River, mile 262.4, 1850 m., 30 Apr 1974, *Lauer sn.* (ID); Payette National Forest, Council Cuprum road (4056 Natl Forest Dev Road 002), above Summit Gulch, N 45° 1' 44.688", W 116° 41' 41.172", 1437 m, 26 Jun 2011, *George 140* (ID); Payette National Forest, Ditch Creek Road, N 44° 53.912', W 116° 42.852', 4889 ft, 24 Jun 2011, *Smith 9644* (ID); Payette National Forest Road 002, ca. 1 mi W of jct with Forest Service Road 071, N 45° 3' 14.8314", W 116° 42' 23.22", 4858 ft., 26 Jun 2011, *Ardern 11-89* (ID); 1.6 mi from turnoff at Bear to Cuprum along FR 002, N 45° 1.88', W 116° 41.753', 4760 ft., 23 Jun 2014, *Polito 043* (CIC, ID, OSC); near the turnoff at Bear to Cuprum, ca. 0.8 mi W of junction between FR 002 and FR 071 on FR 071, N

45° 1.869', W 116° 43.611', 4913 ft, 23 Jun 2014, *Polito 044* (CIC, ID, OSC, NY); on Payette Forest Rd 071, 6 mi S of turnoff from Bear/Cuprum road and 2.7 mi from OX Ranch, ca. 6 mi SW of Bear, N 44.98783°, W 116.72482°, 4500 ft, 14 Jun 2016, *Mansfield 16056* (CIC, ID, NY); on Council-Cuprum road, 1.1 mi S of OX Ranch turn off, and just S of Lick Creek Crossing, N 44.98137°, W 116.66527°, 4356 ft, 14 Jun 2016, *Mansfield 16057* (CIC, ID); on Bear/Cuprum road, 1.4 mi from the turnoff from Bear to Cuprum, on N side of road, NW of Council on Council Cuprum road, N 45.0409°, W 116.69463°, 4693 ft, 14 Jun 2016, *Mansfield 16044* (CIC, ID, NY, SRP); on Bear/Cuprum road, 3.3 mi from the turnoff from Bear to Cuprum, on N side of road, N 45.02935°, W 116.70708°, 4940 ft, 14 Jun 2016, *Mansfield 16048* (CIC, ID, NY, OSC, WTU); on Forest Rd 071, 4.3 mi S from Bear/Cuprum road, ca. 7 mi SW of Bear ID and six and a half miles W of OX Ranch, N 44.99456°, W 116.74632, 4700 ft, 14 Jun 2016, *Mansfield 16053* (CIC, ID, NY, WS). **Oregon**. Baker Co.: Vic. Copperfield, Hell's Canyon, Hess road, ca. 5 mi from canyon bottom, N 45.071427°, W 116.825775°, 1246 m, 12 Jun 2010, *Hinchliff 891* (CIC, SRP). Wallowa Co.: Wallowa Whitman National Forest, N 45.1195°, W 116.7920°, T05S R48E S24 NE1/4 of NW1/4, 3130 ft, 13 Jun 2013, *Yates 1065* (CIC, OSC, WWNF); Wallowa Whitman National Forest, N 45.12866°, W 116.78901°, 3050 ft, *Yates 1064* (CIC, OSC, WWNF).

Etymology

The epithet "*basalticum*" refers to the distinctive red, weathered entablatures of the Miocene Columbia River Basalt Group substrate that distinguishes this species substrate preference from the related species, *Lomatium brunsfeldianum*, which grows on intrusive or metamorphic substrates.

Figure 1 (left). *Lomatium basalticum* habit. The plant is ca. 45 cm tall.

Figure 2 (right). *Lomatium basalticum* root. Stems emerge from branched root, lacking a long-lived caudex All photos by the first author unless otherwise noted.

Figure 3. *Lomatium basalticum* cauline leaf. The leaf is ca. 20 cm long.

Habitat

Lomatium basalticum is known from open, gravelly, dry meadows and gently sloping, rocky, xeric sites in ponderosa pine and mixed conifer forest openings. The type locality in the Wallowa Whitman National Forest in Wallowa Co., Oregon, and is on frigid, silty loam inceptisol soils of the Albee-Bocker Complex on parent material of mixed volcanic ash, loess, and colluvium derived from highly weathered, often red, entablature basalt of the Middle and Lower Miocene (15-17 MYA) Grande Ronde basalt flows (WebSoilsSurvey 2016; USGS 2016) between 900 and 1900 m in grassland/forb communities dominated by *Pseudoroegneria spicata, Poa secunda* subsp. *secunda,* and *Festuca idahoensis*, often with surrounding stands of *Pinus ponderosa* forest on adjacent colonnade basalts (Figs. 10 A & B). Additional associated species found with *Lomatium basalticum* include *Achillea millefolium*, *Artemisia rigida*, *Astragalus reventus, Balsamorhiza hookeri, B. sagittata*, *Bromus carinatus, Eriogonum heracleoides, E. sphaerocephalum* var. *halimioides, E. umbellatum* var. *ellipticum, Ipomopsis aggregata* subsp. *aggregata, Lomatium dissectum var. multifidum, L. leptocarpum, L. macrocarpum, L. nudicaule, Perideridia bolanderi, Purshia*

tridentata, and *Sedum stenopetalum*. When all five of these *Lomatium* species occur on the same site in Adams Co., they mature phenologically in the following order: *L. leptocarpum* is earliest, followed by *L. dissectum* var. *multifidum*, then *L. nudicaule*; *L. macrocarpum* and *L. basalticum* mature last.

Range

Lomatium basalticum is presently known from only northwestern Adams Co., Idaho, southeastern Wallowa Co., Oregon, and northeastern Baker Co., Oregon, between the N latitudes of 44.898° and 45.167° and the W longitudes of 116.665° and 116.792°.

Similar species

Lomatium basalticum is similar to *L. brunsfeldianum* and *L. grayi* and best distinguished from those species in the field by ten characters (Table 1). A principal components analysis (SIGMA PLOT 13 2016) of 8 specimens of *L. basalticum*, 6 of *L. brunsfeldianum*, and 4 of *L. grayi* using the 10 characters shown in Table 1 and 11 additional characters, shows the three species clearly distinguished (Fig. 7). *Lomatium basalticum* is best distinguished from *L. brunsfeldianum* by its fruit characteristics –– having thicker, and to a lesser extent, longer and wider fruits, and also by glabrous stems and foliage and a wider leaf sheath (F.ig 8, Table 1). *Lomatium basalticum* is completely allopatric with *L. brunsfeldianum*, the latter of which is unknown south of latitude 46.236 in north-central Idaho, Montana, and British Columbia.

Lomatium brunsfeldianum is ecologically well-differentiated from *L. basalticum*. *Lomatium brunsfeldianum* is lower in elevation (450 to 1000 m), on granite or metamorphosed slates and quartzites from Precambrian Belt Series rocks. It is restricted to wet, mossy cliffs amidst northern coniferous forest dominated by some combination of *Abies grandis, Alnus rubra, Larix occidentalis, Picea engelmanii, Pinus monticola, Pseudotsuga menziesii, Thuja plicata*, and *Tsuga heterophylla*, with a well-developed shrub layer including some combination of *Amelanchier alnifolia, Cornus sericea, Holodiscus discolor, Philadelphus lewisii, Physocarpus malvaceus*, and *Vaccinium membranaceum*. Understory associates of *L. brunsfeldianum* include *Claytonia cordifolia, Collinsia parviflora, Cystopteris fragilis, Dactylis glomerata, Fragaria vesca, Lomatium ambiguum, L. dissectum* var. *multifidum, Mimulus clivicola, M. guttatus, Orobanche fasciculata, Penstemon wilcoxii, Poa bulbosa, Polypodium hesperium, Sedum stenopetalum, Saxifraga occidentalis*, and *S. caespitosa*.

Lomatium grayi is widespread and grows sympatrically with *L. basalticum*. *Lomatium grayi* often is glaucous, and all populations of *L. grayi* observed in sympatry with *L. basalticum* were glaucous, so throughout the latter's range the two species are readily distinguished (Fig. 9). *Lomatium basalticum* is readily distinguished from *L. grayi* by the much shorter distance from rachilla to basal pinnules of tertiary leaflets, the shorter-lived habit, lacking a substantial caudex with a thatch of old, fibrous leaf sheaths, a narrower, thicker fruit wing, a much larger fruit aspect (length/width) ratio, and by never possessing a glaucous body as often seen in *L. grayi* (Figs. 8 and 9, Table 1). The features of the fruits of the three species are illustrated in Figure 6. Additionally, mature fruit mass, though not a good field characteristic, is perhaps the most discriminating of characters.

L. basalticum: 34.3 ± 14.5 mg/schizocarp
L. brunsfeldianum: 4.8 ± 0.1 mg/schizocarp
L. grayi: 6.7 ± 1.8 mg/schizocarp

Masses were determined by n = 3-4 populations of 15-20 largest mature fruits per population.

Table 1. Comparison of *Lomatium basalticum* with similar species.

Discriminating Character	***Lomatium basalticum***	***Lomatium brunsfeldianum***	***Lomatium grayi***
Small triangular hairs on lower foliage	Absent	Present	Present
Distance from rachilla to basal pinnules of tertiary leaflets	0.3–2 mm	0–2 mm	3.3–6.5 mm
Fibrous thatch of old leaf sheaths on caudex	No	Sometimes	Yes
Basal leaf sheath width	11–17 mm	7–12 mm	8–10 mm
Waxy plant surfaces	Green; glabrous	Green; glabrous	Green to gray; glabrous to glaucous
Fruit length	12–21 mm	9.8–17 mm	8.3–14 mm
Fruit width	3–4.8 mm	2–3.8 mm	4.5–5.8 mm
Fruit aspect ratio (length/width)	3.3–5.6	3.3–5.5	1.6–2.2
Fruit thickness	1.2–2.4 mm	0.5–1.1 mm	0.3–2.1 mm
Fruit wing width	0.5–0.9 mm	0.5–0.6 mm	1.3–2.0 mm

Figure 4. *Lomatium basalticum* inflorescence.

Figure 5. *Lomatium basalticum* (left) and *L. brunsfeldianum* (right) schizocarps showing distinctive corky-thickened wing characterizing both species. Note that *L. basalticum* schizocarps are significantly ($p<0.05$, n=8, t-test) wider (3.7 mm ± 0.6 mm) than those of *L. brunsfeldianum* (2.9 mm ± 0.5 mm) and significantly ($p<0.001$, n=8, t-test) thicker (1.6 mm ± 0.4 mm) than those of *L. brunsfeldianum* (0.7 mm ± 0.2 mm).

Figure 6. Schizocarps of *Lomatium grayi* (top row; ca. 10 mm long), *Lomatium basalticum* (middle row; ca. 15 mm long), and *L. brunsfeldianum* (bottom row; ca. 11 mm long).

Figure 7. Principal Components Analysis of *L. basalticum* (a), *L. brunsfeldianum* (b), and *L. grayi* (g).

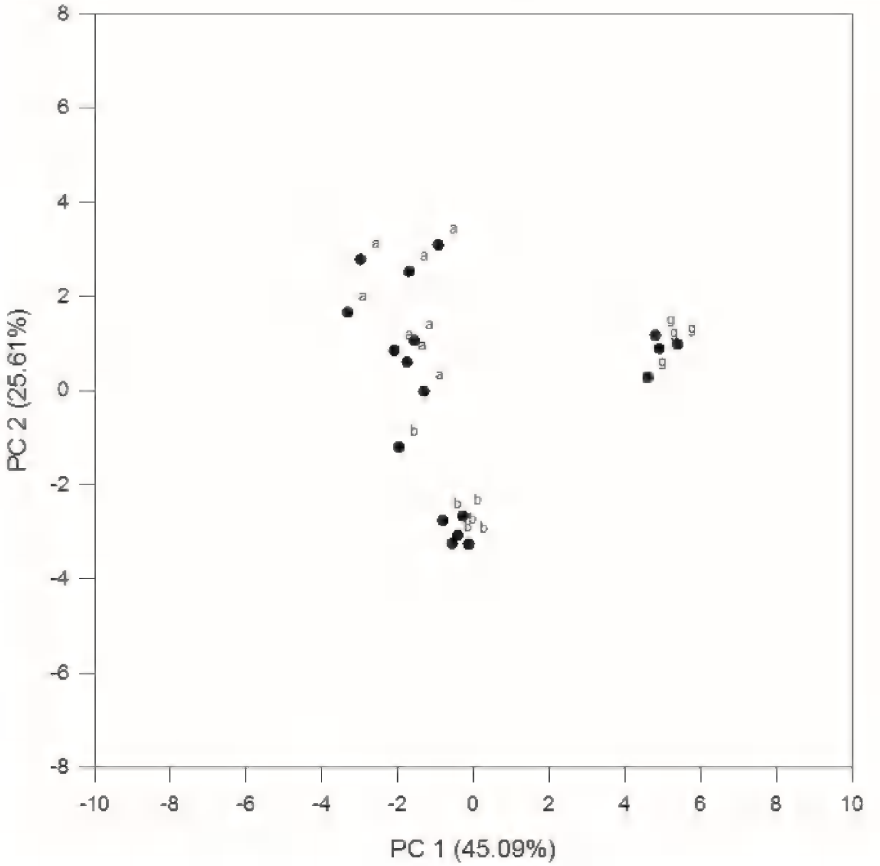

Figure 8. Variables explaining variation among the three *Lomatium* species shown in Figure 7. Each vector indicates the direction and strength of correlation of the variable with thefirst (x-axis) and second (y-axis) principal components.

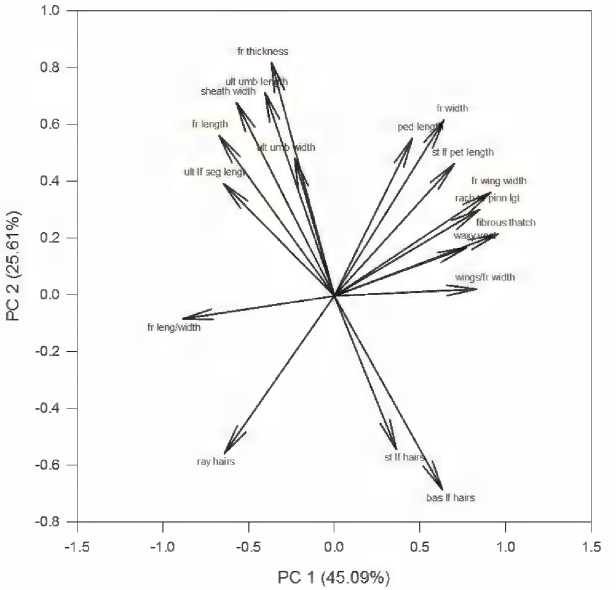

Figure 9. *Lomatium grayi* (left) is often glaucous, and *L. basalticum* (right) is never glaucous.

Figure 10A. *Lomatium basalticum* habitat. Wallowa Co., Oregon. Photo by Gene Yates.

Figure 10B. *Lomatuium basalticum* habitat. Adams Co., Idaho.

Genetics

Methods used by recent phylogenetic studies of *Lomatium* (George et al. 2014) have been extended to the clades including *L. basalticum*, *L. brunsfeldianum*, and *L. grayi* (Fig. 11). *Lomatium basalticum* is monophyletic and sister to *L. brunsfeldianum* yet also closely related to *L. grayi*.

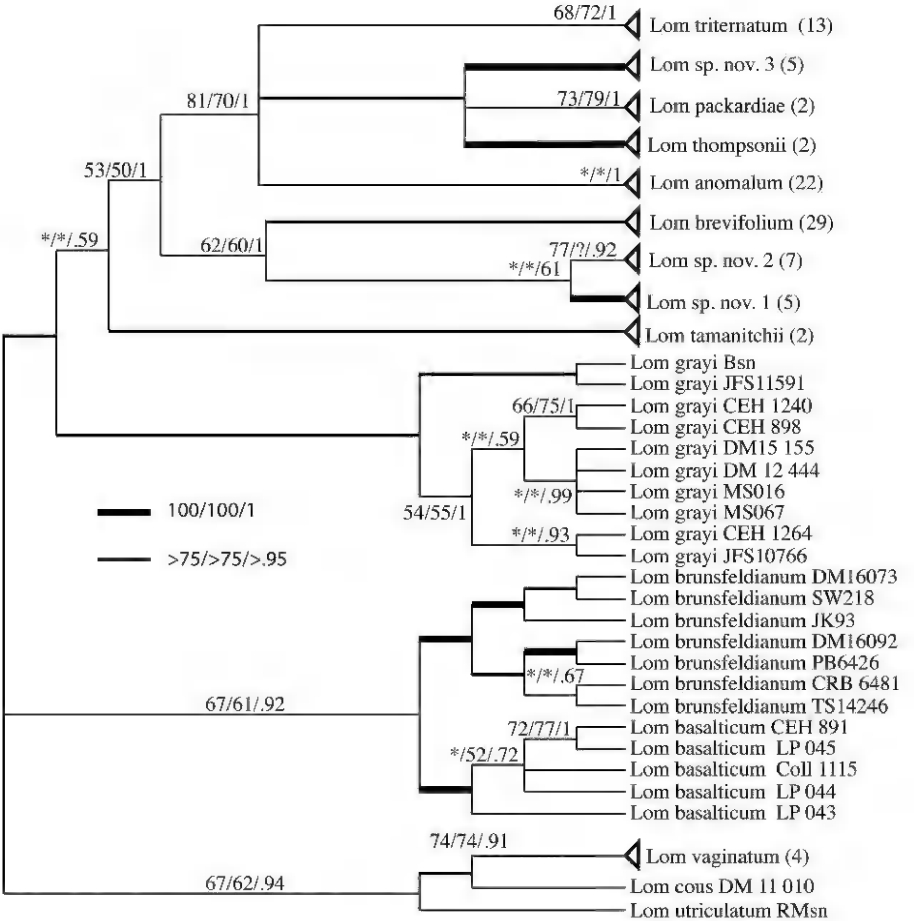

Figure 11. Cladogram showing support for monophyly of *Lomatium basalticum*. Support values indicated as a/b/c are from three analyses, where a = maximum parsimony bootstrap values, b = maximum likelihood bootstrap values, and c = posterior probabilities of 1-model Bayesian analysis. Collection voucher information available on request to the first author.

ACKNOWLEDGEMENTS

We thank Gene Yates for providing two important collections from Oregon, curators of the herbaria cited (ID, NY, OSC, RM, WS, WTU, WWNF) for providing access to material, and Barbara Wilson, Rick McNeill, and Guy Nesom for reviewing and commenting on the paper.

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ATYPICAL COLOR VARIATION IN *MIMULUS RINGENS* (PHRYMACEAE)

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ABSTRACT

Atypical corolla throat color variation in *Mimulus ringens* is documented here by photos of a single plant from Edgefield County, South Carolina. The throat has white palate ridges densely maculate with deep purple blotches, in contrast to light yellow to white palate ridges characteristic of the species.

Corollas of *Mimulus ringens* L. have been described as "violet blue, lavender, sometimes pinkish, or rarely nearly white, throat shaded with yellow and with reddish purple spots below Godfrey & Wooten 1981). The yellow to white palate ridges usually are marked with small, light brown to purplish spots that do not alter the general ridge color (e.g., Fig. 1).

Figure 1. *Mimulus ringens* with typical corolla throat coloration –– palate ridges are yellow with small purplish spots. Photo by Nathan Howell.

On 10 August 2016, the author discovered a single plant of *Mimulus ringens* possessing a deep purple throat coloration –– the white palate ridges densely maculate with purple blotches (Figs. 2-3). The plant was in the headwaters of Turkey Creek in northeastern Edgefield Co., South Carolina (33.870251, –81.881475). This plant was growing in a bedrock crevice (Fig. 4) along the left descending bank about 150 meters downstream of the Old Chappell Ferry Road crossing of Turkey Creek. Observations on the structure of any surrounding *Mimulus* populations were not made during the site visit. The cause of the unusual throat coloration is unknown.

Populations of *Mimulus ringens* in the southeastern USA are identified as var. *ringens* (Weakley 2015).

Figure 2. *Mimulus ringens* corolla with deep purple corolla throat coloration. Photo by Nathan Howell.

Figure 3. *Mimulus ringens* corolla with deep purple corolla throat coloration. Photo by Nathan Howell.

Figure 4. Atypical plant of *Mimulus ringens* growing in bedrock crevice. Photo by Nathan Howell.

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KEYS, DISTRIBUTION, AND TAXONOMIC NOTES FOR THE LOBELIAS (*LOBELIA*, CAMPANULACEAE) OF ALABAMA AND ADJACENT STATES

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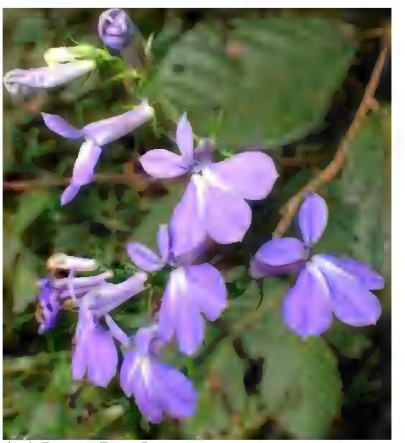
ABSTRACT

The genus *Lobelia* (Campanulaceae) is represented by 22 species and one hybrid in the five-state region of Alabama, Georgia, Florida, Mississippi, and Tennessee. *Lobelia rogersii*, formerly regarded as a hybrid, is recognized here as a distinct species. Keys, distribution maps, photographs, and taxonomic notes are provided for each species.

North American species of *Lobelia* are annual or perennial herbs with alternate, simple leaves and conspicuous blue, white, red or purplish flowers (Fig. 1). The corolla is tubular, often fenestrate, bilabiate, and five lobed (Fig. 2). The upper two lobes are usually erect and the lower three lobes are typically fanned out. Five stamens are united to create a diagnostic matchstick-like structure. The longer, lower portion forms the filament tube and the upper, darker part is the anther tube (Fig. 3). The style passes through the center of the structure and the 2-lobed stigma is exserted at the top.

(1a) Photo: Wayne Barger



(1b) Photo: Dan Spaulding

Figure 1. (a) *Lobelia cardinalis*, Jackson Co., Alabama, Walls of Jericho, along stream margin, 23 Aug 2007. (b) *Lobelia georgiana*, Cleburne Co., Alabama, pond margin, 12 Oct 2014.

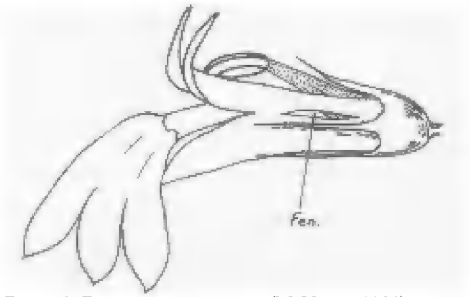


Figure 2. Fenestrate corolla tube (McVaugh 1936).

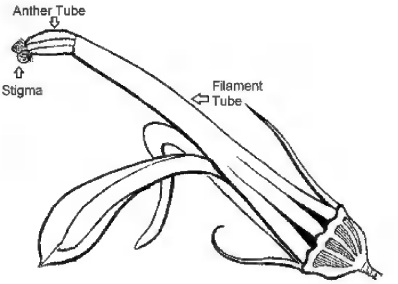


Figure 3. Anther & filament tube (Trelease 1879).

The southeastern USA has more species of *Lobelia* than any other region in North America outside of Mexico (McVaugh 1943). The majority of these Southeast taxa are concentrated within the Coastal Plain (McVaugh 1936). Of the 27 species that occur in the eastern USA, a total of 22 are found in Alabama (15 spp.) and the adjacent states of Georgia (16 spp.), Florida (14 spp.), Mississippi (10 spp.), and Tennessee (9 spp.). One hybrid, *L.* ×*speciosa* Sweet [*L. cardinalis* L. × *L. siphilitica* L.], has been documented from a single county in Alabama and nowhere else in the region. Lobelias often grow in moist to wet habitats, but a few species can tolerate drier conditions (Lichvar 2013).

Worldwide there are about 415 species of *Lobelia* (Lammers 2011) with their center of distribution occurring in the tropics and subtropics (Wimmer 1953). Circumscription of the family is controversial, and some authors (Alexandre 2007, Lammers 2011) place *Lobelia* and its relatives in the Campanulaceae (Bellflower Family) within the subfamily Lobelioideae, while others (Gustafsson & Bremer 1995, Hong & Wang 2014) put them in their own family, the Lobeliaceae. All lobelias in eastern North America belong to sect. *Lobelia* except for *L. homophylla* F.E. Wimm., which is in sect. *Stenotium* (Lammers 2011) and only occurs in Florida. According to Lammers (2011), sect. *Lobelia* is nearly endemic to eastern and central North America. The exceptions are *L. dortmanna* L., which occurs in northern regions of North America and Europe; *L. kalmii* L., which is found across Canada and northern USA; and *L. cardinalis*, which is native to the Americas, from southeastern Canada south through the USA, and Mexico to northern Colombia.

The genus *Lobelia* honors the memory of Mathias de l'Obel (1538–1616), a Flemish physician and botanist who published monumental works on plant classification (Shosteck 1974). The generic name was coined in 1703 by Charles Plumier (1646–1704), a French botanical explorer who discovered a new plant in the West Indies and named it after l'Obel (Lloyd & Lloyd 1909). Linnaeus (1753) retained Plumier's genus from his polynomial and created the binomial *Lobelia plumieri*. However, Plumier's original name for his maritime shrub was later transferred to a new genus and is now known as *Scaevola plumieri* (L.) Vahl, which is actually in the family Goodeniaceae. Since this species was transferred to a different genus, another type species had to be assigned. Bowden (1959a) states that Britton and Brown (1913) selected *L. dortmanna* as the type and McVaugh (1943) accepted it. However, Lammers (2011) argues that the type species is *L. cardinalis*, which was designated by Hitchcock and Green (1929), and it supersedes the earlier choice of *L. dortmanna* (Fig. 4).

Figure 4. J.E Smith 1793.

Despite the detailed studies completed in the 20th century on *Lobelia* by McVaugh (1936, 1940, 1943), Wimmer (1943, 1953, 1968) and Bowden (1959a, 1959b, 1960a, 1960b, 1961, 1964, 1982), many botanists still have had difficulty identifying species of the southeastern USA. Oddly, the taxa with showy blue flowers are the ones that have caused the most problems. Ward (1978) stated that the difficulties of identification "lie almost entirely in the group of blue large-flowered species." Many of the troubles arise because some of the characters used in taxonomic keys are variable and not always reliable.

Another factor contributing to the misidentification of large blue-flowered species is that McVaugh (1936) did not include a supposed hybrid between *L. brevifolia* Nutt. ex A. DC. and *L. puberula* Michx. in his key. Bowden (1961) subsequently named the hybrid in honor of Rogers McVaugh and called it *Lobelia ×rogersii,* but like McVaugh, he did not create a key to separate it from closely related members of the genus. This taxon was omitted in all taxonomic keys from the time it was recognized. Because of its exclusion, *L. ×rogersii* was almost always incorrectly identified as *L. puberula*, *L. georgiana* McVaugh or *L. amoena* Michx. This study determined that *L. ×rogersii* is actually a valid species and now, for the first time, it is included in a key and can be identified. It should also be noted that a new large-flowered species, *Lobelia apalachicolensis* Spaulding, Barger, & Horne, was recently named from the Apalachicola region of the Florida Panhandle (Spaulding et. al 2016). This species had been collected in the past but was originally misidentified as *L. georgiana*, *L. glandulosa* Walt., or as a hybrid between *L. georgiana* and *L. puberula*.

The keys that follow were constructed after examining numerous specimens from various herbaria in the eastern USA (ALNHS, AMAL, AUA, BBG, BRIT, FLAS, FSU, GA, GAS, JSU, MISS, MISSA, MO, NCU, TENN, TROY, TTU, UNA, USF, UWAL, UWC, VDB, VSC). Herbarium acronyms can be found in Index Herbariorum (Thiers 2016). Various treatments of *Lobelia* were utilized to assist in creating keys and determining distributions (Bowden 1959a; Godfrey & Wooten 1981; McVaugh 1936, 1943; E.B. Smith 1994; Ward 1978; Weakley & Sorrie 2010; Wimmer 1953). Maps (adapted from Lee 2012) were generated from vouchered herbarium specimens, the institutions listed above, the authors' recently collected specimens, and the Alabama Plant Atlas (Keener et al. 2016). Maps with labeled counties for the five states covered in this study are provided in Appendix A and the names of the Level III Ecoregions (Environmental Protection Agency 2013) are found in Figure 5. Information on taxa is set up in the following format: **Number. Name** author(s) {derivation of specific epithets}. VERNACULAR NAME. Duration/Habit; Habitat; flowering dates. Comments. [*Synonyms*].

Key to *Lobelia* of Alabama and adjacent states

1. Corolla bright red, magenta, rose, or pink (white forms very rare); flowers large, 23–50 mm long (measured from base of calyx); filament-tube 13–33 mm long.

    2. Flowers crimson red (faded in dried specimens); flowers averaging 30–50 mm long; filament tubes averaging 25–30 mm long; plants fertile.....**1. Lobelia cardinalis**
    2. Flowers magenta or pink (often drying darker); flowers averaging 23–35 mm long; filament tubes averaging 17–20 mm long; plants sterile; [a rare hybrid only found when its parents, *L. cardinalis* and *L. siphilitica*, are growing together]..... **2. Lobelia ×speciosa**

1. Corolla blue, purple or white; flowers large or small, 7–33 mm long; filament tube 2–15 mm long.

3. Leaves chiefly basal and elongate (strap-shaped), linear to oblanceolate; upper stem leaves much reduced; [obligate wetland plants of the lower Coastal Plain].

    4. Sinuses of calyx lobes with small auricles; pedicels with a pair of very small bracteoles (near base next to slender leaf-like bract); corolla tube not fenestrate (lacking lateral slits, but older flowers may be torn and appear fenestrate); filament tube 6–11 mm long; plants of the Florida Panhandle west to Louisiana..... **13. Lobelia floridana**
    4. Sinuses of calyx lobes lacking auricles; pedicels lacking bracteoles (if leaf-like bract is lobed, the lobes may resemble bracteoles); corolla tube fenestrate (with lateral slits near base between the calyx lobes); filament tube 3–4.5 mm long; plants of extreme southern Georgia and Florida (extending into the eastern portion of the Florida Panhandle)..... ..... **14. Lobelia paludosa**

3. Leaves usually evenly distributed along stem, leaf shape various; upper stem leaves typically only gradually reduced or similar in size to basal leaves.

    5. Flowers relatively large, 15–33 mm long; filament tube 6–15 mm long; corolla usually fenestrate (with a slit or window on each side of the tube between the calyx lobes), except for *L. flaccidifolia*, which is usually not fenestrate.

        6. Leaves mostly less than 3 cm long and very numerous, usually more than 20 (leaves also < 7 mm wide); leaf margins prominently denticulate and apex rounded; sinuses of calyx with distinct auricles that overlap and often completely cover the calyx tube; calyx lobes pectinately toothed..... **6. Lobelia brevifolia**
        6. Leaves 4–15 cm long and less numerous, usually not more than 20 (leaves narrow or broad); leaf margins variously toothed or entire and tips acute or rounded; sinuses of calyx with or without auricles; calyx lobes toothed or entire.

            7. Stem leaves linear, lanceolate or oblanceolate (< 1.5 cm wide) **and** lower lip of corolla densely pubescent basally (on the upper portion near the opening of throat); calyx segments usually toothed (callose-denticulate).

                8. Pedicel with inconspicuous bracteoles borne at base and often hidden by bract (bracteoles are oval to oblong with blunt tips and look similar to glandular teeth of bract, except glands are a little smaller); calyx tube long-hirsute or glabrous with wart-like bumps (pustular); pedicel short to long hirsute or glabrous; corolla tube fenestrate; upper stem leaves prominently denticulate (margins with numerous sharp, gland-tipped teeth); internodes often geniculate (zigzag); plants perennial and usually drying darker ..... **11. Lobelia glandulosa**
                8. Pedicel with two conspicuous bracteoles borne above the base of pedicel (they are linear, somewhat foliaceous, and have acute tips); calyx tube short-pubescent or glabrous with wart-like bumps; pedicel short-pubescent or glabrous; corolla tube usually not fenestrate; upper stem leaves typically not strongly denticulate (but gland-tipped teeth are usually present); internodes not geniculate or only slightly so; plants annual and usually drying a lighter green ..... **12. Lobelia flaccidifolia**

            7. Stem leaves ovate, elliptic, obovate, oblong or lanceolate and corolla lip glabrous **or** corolla lip pubescent basally, but leaves much wider than 1.5 cm; calyx lobes toothed or entire.

9. Underside of corolla with white longitudinal stripes (appearing pinstriped with narrow blue-violet lines with broader white stripes); bracteoles borne above the middle of pedicels just below calyx tube (bracteoles are much smaller than leafy bract, which is found at base of the petiole); calyx lobes entire and usually with some long, chaffy hairs on the margins; sinuses of calyx with small to large auricles; filament tube 12–15 mm long ..... **3. Lobelia siphilitica**

9. Undersurface of corolla not noticeably striped with white; bracteoles located below middle of pedicels, often near the base of leaf-like bract; calyx lobes toothed or entire and margins glabrous or ciliate with sharp-pointed hairs; sinuses of calyx lobes with or without auricles; filament tube 6–11 mm long.

    10. Calyx lobes distinctly toothed (leafy bract at base of pedicel also toothed).

        11. Sinuses of calyx with prominent drooping auricles, often covering half of calyx tube; calyx tube typically densely long-hirsute (occasionally glabrous) ..... **5. Lobelia rogersii**

        11. Sinuses of calyx lacking auricles or with very small and inconspicuous ones; calyx tube long-hirsute or glabrous.

            12. Stems densely pubescent throughout; margins of calyx lobes ciliate with sharp hairs; corolla densely pubescent on the outside ..... **4. Lobelia puberula**

            12. Stems sparsely pubescent to glabrous (more pubescent at the base); margins of calyx lobes glabrous (lacking cilia); corolla mostly glabrous or occasionally sparsely pubescent in lines on the outside.

                13. Lower lip of corolla usually glabrous on upper surface near throat of corolla tube, but occasionally papillate or minutely pubescent (with very short hairs); calyx tube usually glabrous, rarely with a few scattered chaffy hairs, but often with a warty texture; corolla tube glabrous; ranges from Virginia south to Florida and west to Alabama ..... **8. Lobelia georgiana**

                13. Lower lip of corolla distinctly pubescent (with villous hairs) on upper surface near throat of corolla tube; calyx tube long-hirsute or glabrous with a warty texture (two types mixed in the same population); corolla tube glabrous or occasionally pubescent in lines; plants endemic to the Apalachicola region of the Florida Panhandle ..... **10. Lobelia apalachicolensis**

    10. Calyx lobes mostly entire or with a few lobes that are sparingly toothed (ignore leafy bract at the base of pedicel, which is often glandular-toothed).

        14. Auricles very large and conspicuous, covering almost half of calyx tube; lower corolla lip often short-pubescent basally near the throat; [calyx lobes almost always toothed, rarely entire] ..... **5. Lobelia rogersii**

        14. Auricles smaller, less than 1/4 length of calyx tube **or** absent; lower lip of corolla mostly glabrous basally near the throat (exterior of tube can be pubescent).

15. Stems usually densely pubescent throughout (also within inflorescence), but occasionally sparsely pubescent to almost glabrous; calyx lobes lanceolate and mostly erect, typically not flexuous or widely spreading; margins of calyx lobes often ciliate, occasionally smooth; calyx tube densely hirsute, sparsely hirsute to glabrous; auricles present or absent; corolla tube usually pubescent on the outside, rarely glabrous..... **4. Lobelia puberula**

15. Stems sparsely pubescent to glabrous, usually more hairy at the base; calyx lobes linear or lanceolate and often spreading or flexuous (especially the tip, which are sometimes twisted); margins of calyx lobes glabrous (lacking cilia); calyx tube smooth to warty in texture, very rarely sparsely hirsute; auricles absent to almost obsolete; corolla tube essentially glabrous.

    16. Some calyx segments with a few slender, flexuous teeth (sometimes teeth can be completely lacking in an individual of a population, but typically there are a few lobes remotely toothed near base, so check several flowers); leaves typically thick with a parchment-like texture and sometimes with a bluish to gray-green sheen when dried (typically strongly glaucous underneath); uppermost leaves distinctly slender-toothed with callus or gland-tipped teeth..... **9. Lobelia georgiana**

    16. All calyx segments entire, not toothed (ignore leafy bract at the base of pedicel, which is often glandular-toothed); leaves thick or thin, whitish to greenish underneath; uppermost leaves entire or toothed (with or without callus or gland-tipped teeth).

        17. Leaves usually thin and flexuous; leaf edges thin, not thickened; leaf shape elliptic, ovate or broadly lanceolate, mostly 1.5–4.5 cm broad; leaf margins toothed, shallowly crenate or almost entire; leaf apex rounded, obtuse or short-acute; flowers loosely arranged; anther tube 2.5–3.5 mm; filament tube 5–7 mm long; plants chiefly of the mountains and piedmont, rarely of adjacent coastal plain ..... **7. Lobelia amoena**

        17. Leaves thick and stiff; leaf edges frequently with a thickened lip; leaf shape lanceolate to broadly lanceolate, typically less than 2.5 cm broad; leaf margins often distinctly toothed; leaf apex regularly long-acute to acuminate; flowers usually densely arranged; anther tube close to 4 mm long; filament tube 8–11 mm long; plants chiefly of the Atlantic Coastal Plain, rarely of adjacent Piedmont..... **8. Lobelia elongata**

5. Flowers smaller, 8–14 mm long (measured from base of calyx); filament tube, 2.5–5 mm long; corolla usually not fenestrate (except sometimes in *L. flaccidifolia*).

    18. Stem leaves very narrow, most less than 5 mm wide (lowest leaves may be broader).

19. Leaves subulate-filiform (narrowly linear), not exceeding 0.5 mm wide (leaves often deciduous); calyx glabrous; pedicels lacking bracteoles (bracts are present); stems often spongy-thickened toward the base; rhizomes present ..... **19. Lobelia boykinii**
19. Leaves linear to linear-oblanceolate, 1–4 mm wide; calyx glabrous or pubescent; pedicel with bracteoles (found just above larger bracts); stems not spongy-thickened; rhizomes absent.

    20. Lower lip of the corolla glabrous; pedicels and calyx glabrous or pubescent with scattered straight hairs (they are spreading and often tooth-like with slightly broader bases); calyx tube short-hemispheric in fruit; basal leaves (when present) spatulate..... **20. Lobelia nuttallii**
    20. Lower lip of corolla pubescent inside at the base near throat of tube; pedicels and calyx often strongly antrorsely scabrid (with sharp upward pointing hairs), rarely almost glabrous (usually has a few antrorse hairs, especially on pedicel); calyx tube oval to oblong in fruit; basal leaves linear ..... **18. Lobelia canbyi**

18. Stem leaves broader, the largest greater than 10 mm wide.

    21. Lower leaves with distinct petioles; leaf bases truncate, rounded or subcordate; plants restricted to Florida and extreme southern Georgia.

        22. Blades of lower leaves orbicular with entire to shallowly crenate margins; lower stems trailing, forming mats and usually rooting at the nodes (upper stems erect)..... **21. Lobelia feayana**
        22. Blades of lower leaves ovate with deeply crenate to incised-dentate margins; lower and upper stems erect ..... **23. Lobelia homophylla**

    21. Lower leaves sessile or rarely with very short petioles (< 2 mm long); leaf base narrowed, not truncate, rounded or subcordate; plants collectively widespread, not restricted to Florida or Georgia.

        23. Stems long hirsute; fruiting capsules strongly inflated; lower flowers with ovate-leafy bracts; inflorescence usually much branched ..... **22. Lobelia inflata**
        23. Stems glabrous or short-pubescent (base sometimes densely pubescent); fruiting capsules not inflated; flowers with smaller bracts; inflorescence branched or unbranched.

            24. Bracteoles conspicuous (somewhat foliaceous) and borne just below the middle of the pedicel (well above larger bract); calyx lobes toothed (some segments may be remotely toothed); flowers typically larger, 14–20 mm long (measured from base of calyx) ..... **12. Lobelia flaccidifolia**
            24. Bracteoles inconspicuous and borne at the base of the pedicel (adjacent to larger bract); calyx lobes mostly entire, rarely with a few teeth, though sometimes ciliate (ignore the leafy bract at the base of pedicel); flowers smaller, 15 mm or less long.

25. Upper stem leaves oblong or obovate with narrowed bases; leaf margins often entire with tiny glandular teeth or occasionally undulate, crenulate to shallowly dentate; base of stem often densely puberulent; plants rarely branched (if branched, then from lower two nodes, unless injured or late in season after main inflorescence has fruited); inflorescence spike-like with flowers 7–12 mm long that are borne on all sides; flowering mostly June–August ..... **15. Lobelia spicata**

25. Upper stem leaves short-ovate with broad, rounded bases (often partially clasping stem); leaf margins usually irregularly toothed with rounded teeth; plants often branched from lower and upper nodes (occasionally unbranched); inflorescence a raceme with flowers 10–15 mm long that are often borne on one side (secund); flowering mostly May–June.

    26. Calyx lobes ciliate-margined with thick, sharp hairs (at least near apex); sinuses of calyx with auricles; plants of prairies and other open areas on the Coastal Plain of eastern Alabama west to Texas ..... **16. Lobelia appendiculata**

    26. Calyx lobes with glabrous margins; sinuses of calyx lacking auricles; plants of limestone glades on the Interior Low Plateau of Tennessee and adjacent Kentucky ..... **17. Lobelia gattingeri**

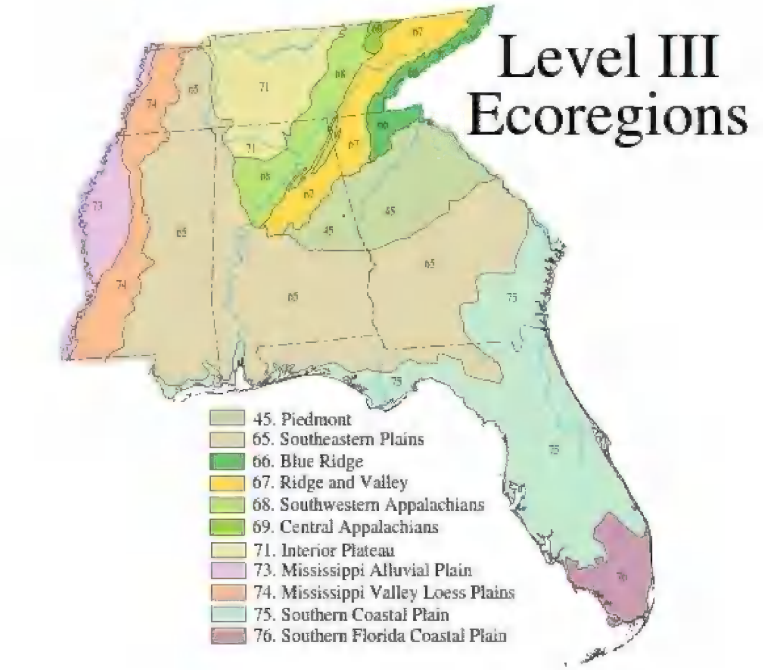
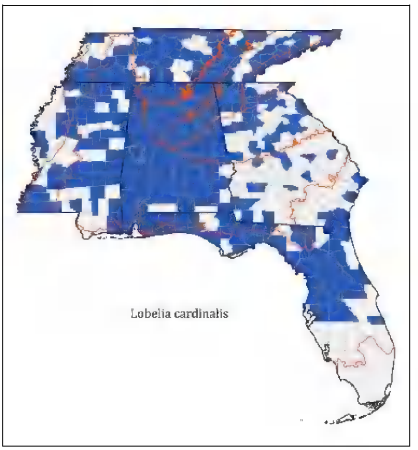


Figure 5. Ecoregions of Alabama, Florida, Georgia, Mississippi, and Tennessee (EPA 2013).

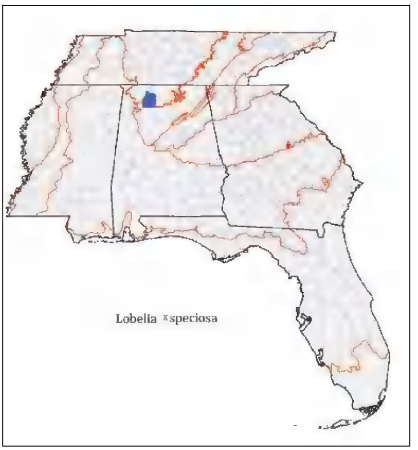
1. Lobelia cardinalis L. {like the Cardinal} — CARDINAL-FLOWER (Figs. 1a & 6). Perennial herb.



Marshes, stream margins, ditches, riverbanks, wet woodland borders, and bottomland hardwoods; late July–October. Cardinal Flower is common from southeastern Canada south through the eastern and southwestern USA, south through Mexico to northern Colombia. *Lobelia cardinalis* is entirely pollinated by hummingbirds and is closely related to the blue-flowered *L. siphilitica*, which is primarily pollinated by bumblebees (Thompson & Lammers 1997). These two species rarely hybridize in the wild due to their different pollinators and flowering times. The common name, Cardinal-Flower, refers to red robes worn by Catholic cardinals (Coffey 1993). *Lobelia cardinalis* has a long history of cultivation; the entities with broad leaves have been identified as *L. cardinalis* and the frost-tender, narrow leaved plants were called either *L. splendens* or *L. fulgens* (Thompson & Lammers 1997). The narrow leaved form of this species was treated by McVaugh (1943) as *L. cardinalis* subsp. *graminea* and he further subdivided this subspecies into four varieties. Bowden (1964) named a variety under subsp. *cardinalis* and stated that "variety *meridionalis* seemed to me to be so distinctive that the taxon merited a name. I have never seen specimens of var. *cardinalis* that had such coarse stems, and no specimens of var. *cardinalis* were seen that had procumbent stem bases rooting along the portions next to the soil." Variety *meridionalis* is endemic to Florida, and Ward (1978) says that it "is often much more robust, with pronounced horizontal bases and stout aerenchyma-filled stems that float or are supported in the water of spring runs and along the edges of clearer rivers." However, Thompson and Lammers (1997) concluded "that the complex comprises a single species, *L. cardinalis*, and that this species cannot be divided into infraspecific taxa." [*Lobelia cardinalis* subsp. *cardinalis* var. *meridionalis* Bowden; *L. cardinalis* ssp. *graminea* (Lam.) McVaugh var. *graminea*; *L. cardinalis* subsp. *graminea* var. *multiflora* (Paxton) McVaugh; *L. cardinalis* subsp. *graminea* var. *phyllostachya* (Engelm.) McVaugh; *L. cardinalis* subsp. *graminea* var. *pseudosplendens* McVaugh; *L. fulgens* Willd.; *L. splendens* Humb. & Bonpl. ex Willd.]

Figure 6. *Lobelia cardinalis*. Colbert Co., Alabama, stream margin, 22 Sept 2014. Photos: Wayne Barger.

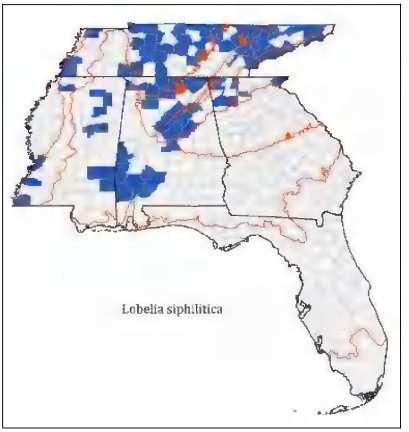
2. Lobelia ×speciosa Sweet {showy} — SHOWY LOBELIA [*L. cardinalis* × *L. siphilitica*] (Fig 7).



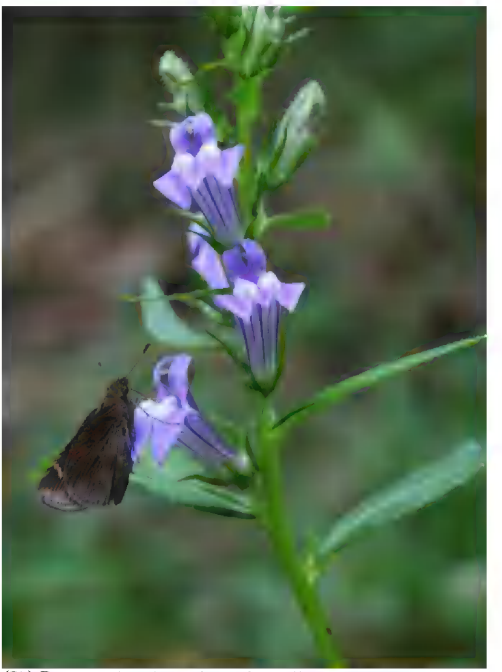
Perennial herb. Wooded floodplains; September–October. This hybrid was recently discovered in Lawrence County, Alabama by Brian Keener and was growing beside its two parents in alluvial woods. Previously it was only known from a few populations in Missouri, Illinois, and Indiana, as well as Ontario and New Brunswick (Kartesz 2016). The morphological characters of this rare hybrid are intermediate between its two parents. Artificial hybrids have been produced many times for gardens, but very few natural hybrids have been collected in the field. Bowden (1964) states that "geographical separation is probably the main factor in limiting the production of natural hybrids of this parentage. The flowering periods of the two species are different; *L. cardinalis* begins to bloom earlier than *L. siphilitica.* However, there is an overlap in the blooming periods of the two species but the changes of interspecific hybridization are lessened by the different peaks in their flowering periods." Flower color of wild hybrids is usually magenta (purplish-red), however horticulturalists have developed a range of colors from rose-red, carmine, pink or white. Most F_1 hybrids are diploid ($2n$ =14) and usually completely sterile, producing no seeds (Bowden 1964). However, *L. ×speciosa* can set some viable seeds if backcrossed to either parent (Bowden 1982).

Figure 7. *Lobelia ×speciosa.* Lawrence Co., Alabama, alluvial woods, 6 Oct 2012. Photos by Joan Rundles.

3. Lobelia siphilitica L. {syphilis} — GREAT BLUE LOBELIA (Fig. 8). Perennial herb. Rich woods, streambanks, alluvial woods, seeps, roadside ditches and drainages, often in neutral or calcareous soils; August–September. Native to eastern and central USA and Canada. In the southeast it is frequent in the Blue Ridge, Appalachian Plateau, Ridge & Valley, and Interior Low Plateau, but less common on the Coastal Plain. The specific epithet "siphilitica" arose from the alleged properties of the plant for curing syphilis (Shosteck 1974). *Lobelia siphilitica* often has large, leafy auricles, but a small-auricled form occurs in the southern part of its range. Specimens with smaller auricles are often mistaken for *L. amoena*, which lacks auricles and has no hairs on its calyx tube or lobes. McVaugh (1936) recognized a western variety, (var. *ludoviciana*), which was said to occur in the Midwest from central Canada and North Dakota east to Wisconsin and south to north Louisiana and Texas. This taxon typically has fewer flowers, narrower leaves, and is almost glabrous (Fig. 8g). However, after examining numerous collections throughout the range of the species, we find that the characters do not hold up. [*Lobelia siphilitica* var. *densiflora* (Rennie) F.E. Wimm.; *L. siphilitica* var. *ludoviciana* A. DC.]



(8a) Flowers.

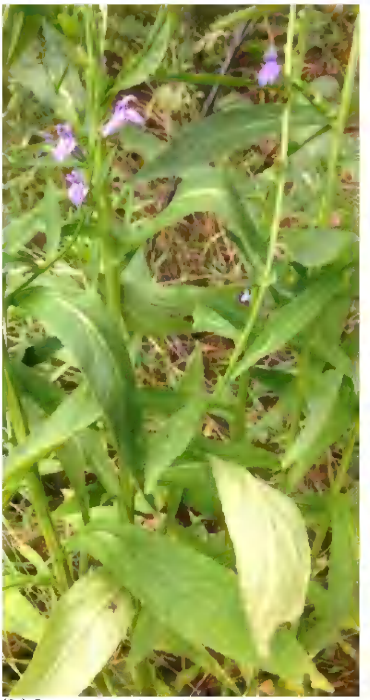


(8b) Pinstriped undersurface of corolla.

(8c) Small auricled form (note ciliate lobes).

(8d) Typical form with large foliaceous auricles.

(8e) Inflorescence.

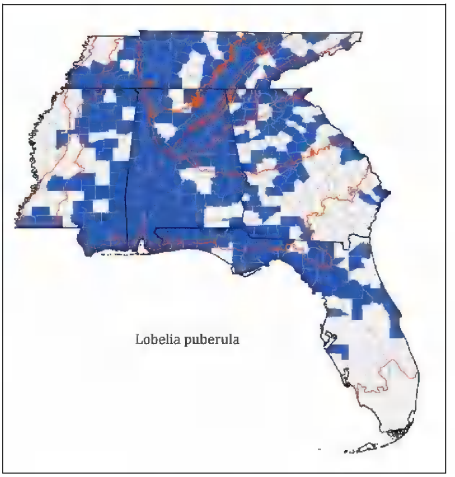


(8f) Leaves are often elliptic.

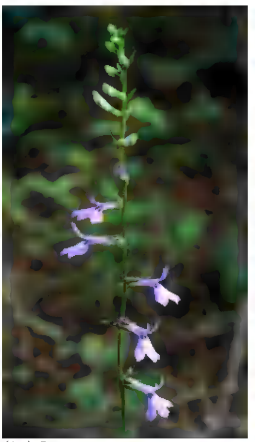
(8g) Western form.

Figure 8. *Lobelia siphilitica.* (a) Etowah Co., Alabama, 23 Sept 2014. Photo: Wayne Barger. (b) Jackson Co., Alabama, 27 Sept 2007. Photo: Wayne Barger. (c) Etowah Co., Alabama, calcareous seep, 15 Oct 2014. Photo: Dan Spaulding. (d) Shannon Co., Missouri, 15 Aug 2003. Photo: Dan Tenaglia. (e & f) Morgan Co., Alabama, 13 Sept 2014. Photo by Dan Spaulding. (g) *Clonts s.n.* (JSU), "*Ludoviciana*" form of *L. siphilitica*, Boone Co., Iowa, 16 Aug 1968.

4. Lobelia puberula Michx. {puberulent} — DOWNY LOBELIA (Fig. 9). Perennial herb. Open woods, woodland borders, streambanks, wooded slopes, ditches, fields, roadsides, and other open areas; July–November. Downy Lobelia is native to eastern and south central United States, from southern Pennsylvania south to Florida, west to Texas and Missouri (Kartesz 2016). It is the most common blue-flowered Lobelia in the Southeast. *Lobelia puberula* is a polymorphic species with numerous forms (McVaugh 1936) that have been considered varieties by some authors (Fernald 1947). It was concluded by the senior author, after examining hundreds of specimens, that the various characters used to separate the varieties are variable and overlapping and not worthy of taxonomic recognition. However, one variety, *L. puberula* var. *pauciflora* Bush (Fig. 10), is so distinct it warrants recognition at species level. This taxon can be distinguished from *L. puberula* by its densely shaggy, white-pubescence on the base of calyx and pedicel, widely spaced flowers, and lanceolate leaves. Turner (1950) elevated *L. puberula* var. *pauciflora* to *L. reverchonii* and noted that when he discovered *L. reverchonii* growing side by side with *L. puberula* in Texas, that: "Their dissimilarity was very strong, even to one unfamiliar with the species. In the area concerned, the two species seemed to be well marked and showed no signs of integration." *Lobelia reverchonii* (as *L. puberula* var. *pauciflora*) was erroneously attributed to Alabama by McVaugh (1943) but, as of now, it is restricted to Louisiana and Texas. [*Lobelia puberula* var. *glabella* Hook.; *L. puberula* var. *laeviuscula* (Hook.) C. Mohr; *L. puberula* var. *mineolana* F.E. Wimm.; *L. puberula* var. *obtusifolia* (DC.) Fernald; *L. puberula* var. *simulans* Fernald]

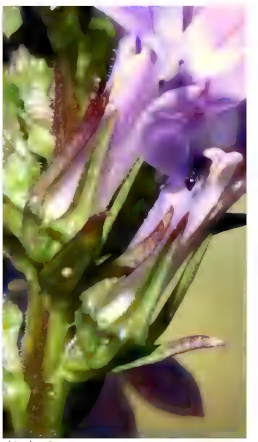


(9a) Flower of common form with hairy calyx and entire calyx lobes.



(9b) Loose inflorescence form.

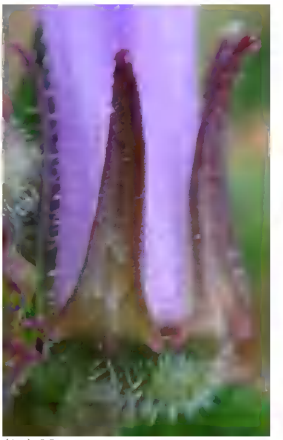
(9c) Dense inflorescence form.



(9d) Glabrous calyx form.

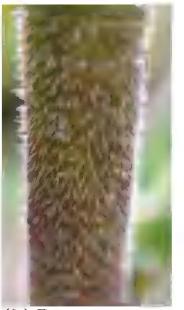
(9e) Toothed calyx lobe form.

(9f) Broad-based calyx lobe form.



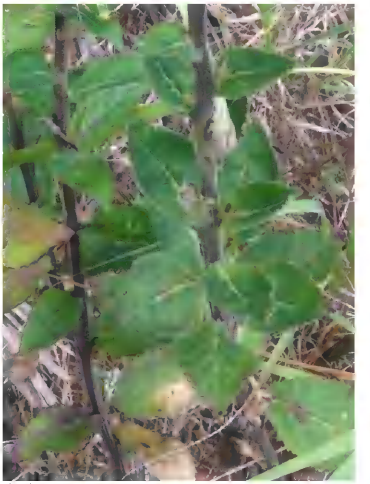
(9g) Narrow-based calyx lobe form.

(9h) Corolla tube is typically pubescent.



(9i) Downy stem.

(9j) Lower lip of corolla glabrous.

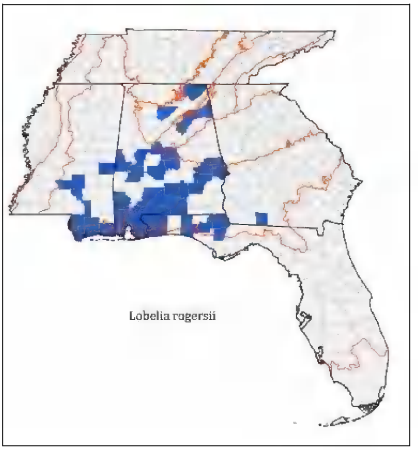


(9k) Leaves often elliptic, obovate or ovate.

Figure 9. *Lobelia puberula*. (a & b) Colbert Co., Alabama, 20 Aug 2014. Photo: Wayne Barger. (c & d) Colbert Co., Alabama, 22 Sep 2014. Photos: Wayne Barger. (e) *Cooley et al. 6908* (USF), Hernando Co., Florida, 15 Sep 1959. (f) *Mikula 4353* (AUA), Amelia Co., Virginia, 11 Sept 1949. (g–j) Calhoun Co, Alabama, 13 Oct 2014. Photos: Dan Spaulding. (k) Etowah Co., Alabama, 13 Sep 2014. Photo: Dan Spaulding.

Figure 10. *Lobelia reverchonii* (= *L. puberula* var. *pauciflora*). *Vincent & Allen 3211* (NCU), Vernon Parish, Louisiana, 4 Nov 1979.

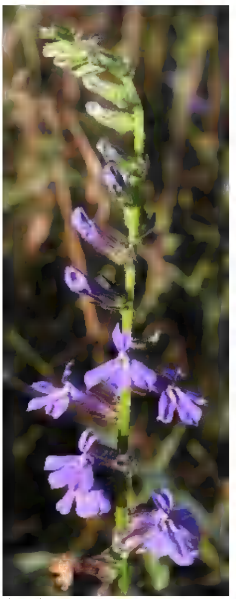
5. Lobelia rogersii Bowden {in honor of Rogers McVaugh (1909–2009), American botanist and *Lobelia* expert} — MCVAUGH'S LOBELIA (Fig. 11). Bogs, seeps, wet flatwoods, and boggy fields; July–November (occasionally earlier or later during mild winters along the coast). Native from eastern Louisiana to southwest Georgia north through Alabama. *Lobelia rogersii* has not been evaluated for its wetland status (Lichvar 2013). Based on the habitat of this species, its wetland indicator status should be Facultative-Wetland (FACW). McVaugh (1936) treated this taxon as a hybrid and listed it as *L. brevifolia* × *puberula*. Bowden (1961) officially named it *L.* ×*rogersii*, but noted that "natural hybrid specimens of *L.* ×*rogersii* occur relatively frequently because some plants are partly fertile" and later he stated it was "behaving partly as a newly formed hybrid and partly as a recently produced species of hybrid origin." The geographic ranges of the two parents overlap in the lower coastal plain, but not further north. Since a large portion of the distribution of this taxon occurs out of the range of *L. brevifolia*, we believe it is a new species of hybrid origin. Both Bowden and McVaugh did not include their hybrid in any taxonomic keys, which caused a lot of misidentification of *L. rogersii*. The chief characteristics of this species are large drooping auricles (they look like elongated ear lobes), toothed calyx lobes (very rarely entire), and densely short-hirsute stems (rarely sparsely pubescent or glabrous). Individuals that are almost glabrous can be confused with *L. georgiana* because both taxa usually have toothed calyx segments; however, *L. rogersii* always has large auricles and *L. georgiana* has very small auricles or none at all.



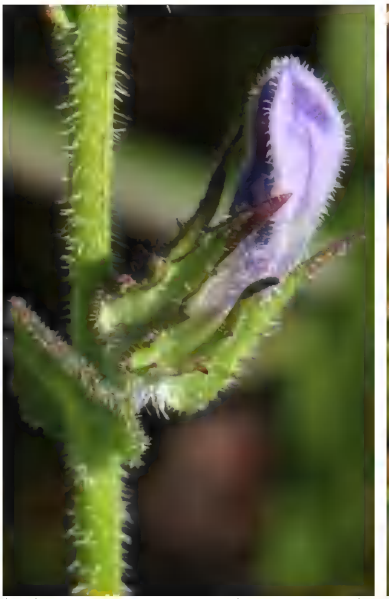
(11a) Toothed calyx lobes, large auricles and hairy calyx tube (rarely glabrous).

(11b) Lower lip of corolla near throat is often short-pubescent.

(11c) Large drooping auricles.



(11d) Infloresecence.

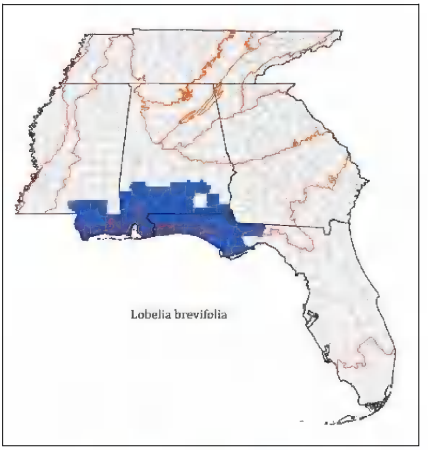


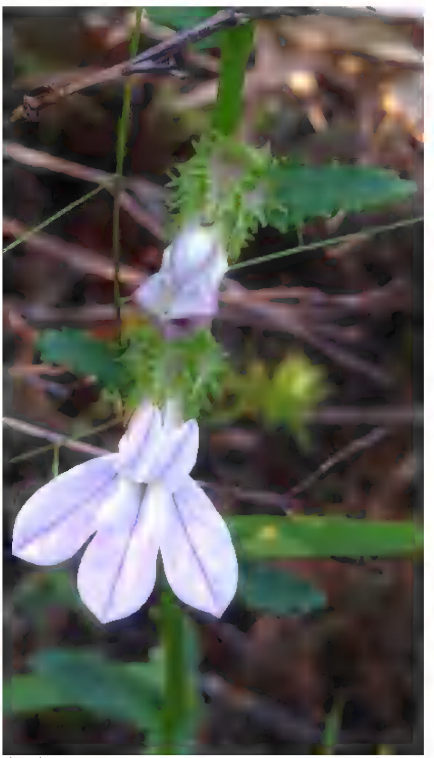
(11e) Hairy stem and flower (rarely glabrous).

(11f) Ovate-elliptic leaves.

Figure 11. *Lobelia rogersii*. (a & b) Stone Co., Mississipi, 27 Oct 2008. Photos: John R. Gwaltney <www.southeasternflora.com> (c) *Moore 1066* (AUA), Baldwin Co., Alabama, 10 Sep 1970. (d–f) Etowah, Co., Alabama, seepage slope, 24 Sep 2014. Photos: Wayne Barger.

6. Lobelia brevifolia Nutt. ex A. DC. {short-leaf} — SHORTLEAF LOBELIA (Fig. 12). Pine savannas, flatwoods, ditches, and bogs; August–November. Endemic to the East Gulf Coastal Plain from the Florida Panhandle west to eastern Louisiana. Kartesz (2016) maps this species in southeastern Georgia (Echols County), but the report has not been verified. There is also an historical herbarium specimen housed at the Carnegie Museum that is supposedly from Lee County, Alabama (CM, *Earle s.n.*, Auburn, 11 Oct 1896), but the location data may be in error. The curator of the Auburn University herbarium doubts the accuracy of the label (pers. comm. Curtis Hansen). Shortleaf Lobelia is very distinct and easy to identify by its numerous, short, denticulate leaves and pectinately toothed calyx lobes. *Lobelia brevifolia* was considered to be one of the parents of *L. rogersii* (Bowden 1961), which is now believed to be a species of hybrid origin.





(12a) Flowers with pectinate calyx lobes.

(12b) Stems with numerous short leaves.

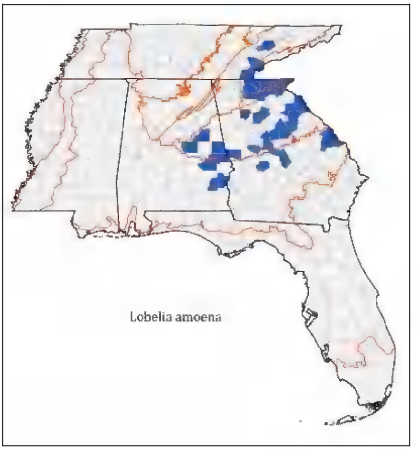
(12c) Denticulate leaf margins.

(12d) Calyx with large auricles and toothed lobes.

(12e) Corolla short-pubescent on outside of corolla and on lower lip near throat.

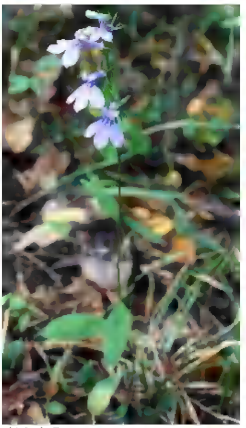
Figure 12. *Lobelia brevifolia*. (a–e) Walton Co., Florida, 20 Oct 2014. Photos: Dan Spaulding & Melanie Taylor.

7. Lobelia amoena Michx. {delightful} — SOUTHERN LOBELIA; PRETTY LOBELIA (Fig. 13).



Perennial herb. Stream banks, creek margins, gravelly areas along rivers, lake banks, seepage slopes, boggy woods, alluvial woods, wet rocky woods, granite outcrops, woodland seeps, base of wet cliffs, and spring margins; August–October. Native from North Carolina to east Alabama. Chiefly occurring in the Blue Ridge and Piedmont, but is occasionally found in adjacent upper Coastal Plain of Alabama, Georgia, South Carolina, and the Cumberland Plateau of Tennessee. *Lobelia amoena* is a commonly misidentified species. Individuals of *L. georgiana* with sparingly toothed calyx lobes are frequently mistaken for *L. amoena*, but *L. amoena* has calyx lobes that lack teeth and also has thinner leaves. *Lobelia amoena* is frequently confused with less pubescent forms of *L. puberula,* but *L. amoena* lacks hair on its corolla and has linear to lanceolate calyx lobes that are often spreading or flexuous. *Lobelia amoena* has not been given its own wetland indicator status because it is lumped under *L. georgiana* (Lichvar 2016). *Lobelia amoena* should be Facultative-Wetland (FACW).

(13a) Glabrous flowers and linear, spreading calyx lobes lacking teeth; note that the bract is toothed.

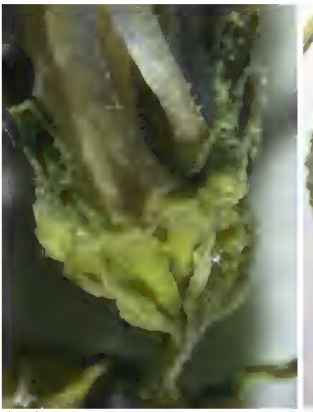


(13b) Inflorescence loose.

(13c) Close-up of inflorescence.

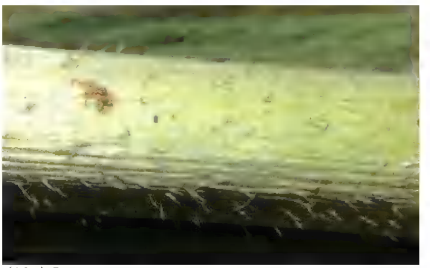
(13d) Calyx is glabrous.

(13e) Cauline leaves with crenate margins.



(13f) Dried calyx.

(13g) Dried leaf.

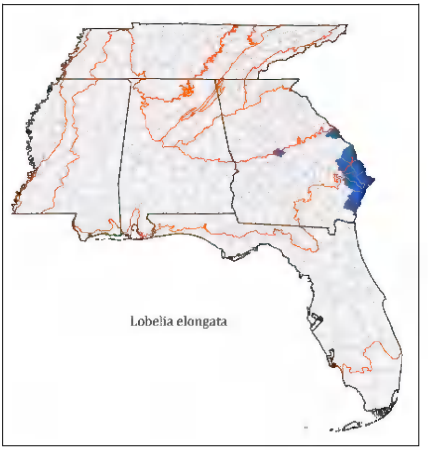


(13h) Lower stem with scattered pubescent.

(13i) Upper stem sparsely pubescent.

Figure 13. *Lobelia amoena*. (a–c) Lee Co., Alabama, 14 Oct 2014. Photos: Wayne Barger. (d) Coosa Co., Alabama, streambank, 12 Oct 2014. Photo: Dan Spaulding. (e) Lee Co, Alabama, streambank, 12 Oct 2014. Photo: Dan Spaulding. (f–i) *Spaulding 14209* (AMAL), Chambers Co., Alabama, 12 Oct 2014.

8. Lobelia elongata Small {elongate} — LONGLEAF LOBELIA; STREAMSIDE LOBELIA (Fig. 14).



Perennial herb. Swamps, marshes, river margins, stream margins, seeps, bogs, swales, saltmarshes, ditches, and wet woods; August–October. Native along the Atlantic Coastal Plain from Delaware south to Georgia, rarely occurring in the adjacent Piedmont. Reports of *L. elongata* from Alabama and Mississippi are all erroneous. This species is very similar to *L. amoena*, which occurs mostly in the Piedmont and Blue Ridge. *Lobelia elongata* differs from *L. amoena* by the combination of the following characters: thicker, strongly toothed, lanceolate leaves; inflorescence with densely arranged flowers; and slightly longer anther tubes (4 mm vs. 2.5–3.5 mm). *Lobelia elongata* is also sometimes confused with *L. georgiana*, which has toothed calyx lobes. *Lobelia elongata* has calyx lobes that lack teeth. Bowden (1959a) reported that a few specimens of *L. elongata* had teeth on their calyx lobes, but these were most likely depauperate specimens of *L. georgiana*. [*Lobelia glandulosa* Walt. var. *glabra* A. DC.]

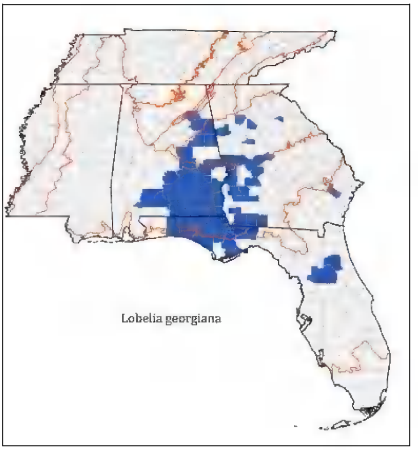
(14a) Inflorescence densely flowered and secund. (14b) Illustraton showing leaves and inflorescence.

(14c) Leaves typically toothed and laceolate (but leaves can occasionally be wider).

(14d) Tight inflorescence. (14e) Glabrous calyx with linear lobes. (14f) Almost glabrous stems.

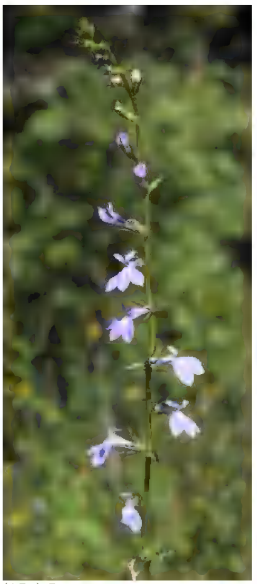
Figure 14. *Lobelia elongata*. (a) Moore Co., North Carolina, acid blackwater stream, 9 Sep 2014. Photo: Bruce Sorrie. (b) Line drawing from Britton and Brown 1913. (c–f) *Zebryk 767* (VDB), Chatham Co., Georgia, drainage ditch, 28 Oct 1992.

9. Lobelia georgiana McVaugh {of Georgia} — GEORGIA LOBELIA (Figs. 1b & 15). Perennial herb.



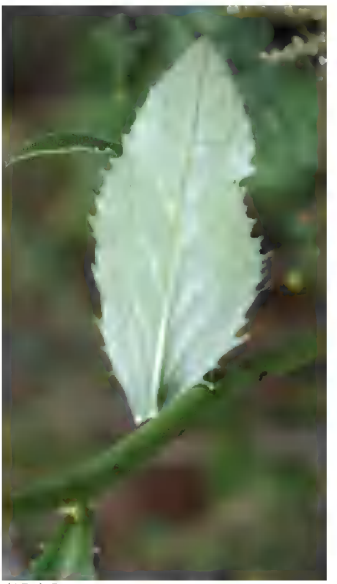
Bogs, ditches, bottomland hardwoods, swamps, floodplain forests, pond margins, and streambanks; August–October. Native to the Piedmont, Ridge & Valley, Blue Ridge, and Coastal Plain provinces from Virginia south to Florida and west to Alabama. Various reports from Mississippi and Louisiana are erroneous and many of these specimens are actually *L. rogersii*, which is similar because of its toothed calyx lobes, but differs by its large auricles. McVaugh (1936) cited a specimen from Knox Co., Tennessee, but stated that it was "possibly an error." Kartesz (2016) lists this taxon for Polk and Monroe counties in Tennessee, but no vouchers are cited. *Lobelia georgiana* is closely related to *L. amoena* and is often considered a variety by some authors (McVaugh 1943). *Lobelia georgiana* usually has thicker leaves, dries more grayish-green, and has toothed calyx segments. In depauperate specimens, the calyx lobes are sometimes only remotely toothed near the base, so several flowers should be examined closely. Some specimens of *L. georgiana* with narrow leaves can appear similar to *L. glandulosa*, but the lower corolla lip of *L. georgiana* is essentially glabrous and lacks the villous hairs that occur basally on the lower corolla lip of *L. glandulosa*. [*Lobelia amoena* Michx. var. *glandulifera* A. Gray; *L. amoena* Michx. var. *obtusata* A. Gray; *L. glandulifera* (A. Gray) Small]

(15a) Calyx lobes toothed and lacking auricles; calyx tube glabrous (very rarely with a few scattered hairs).



(15b) Inflorescence.

(15c) Gland-tipped teeth.



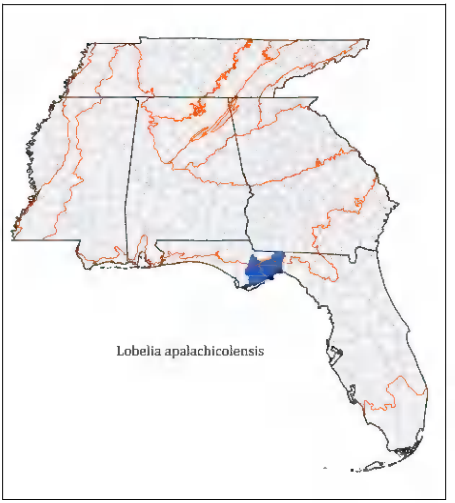
(15d) Leaf undersurface often whitish.

(15e) Lower corolla lip near throat essentially glabrous.

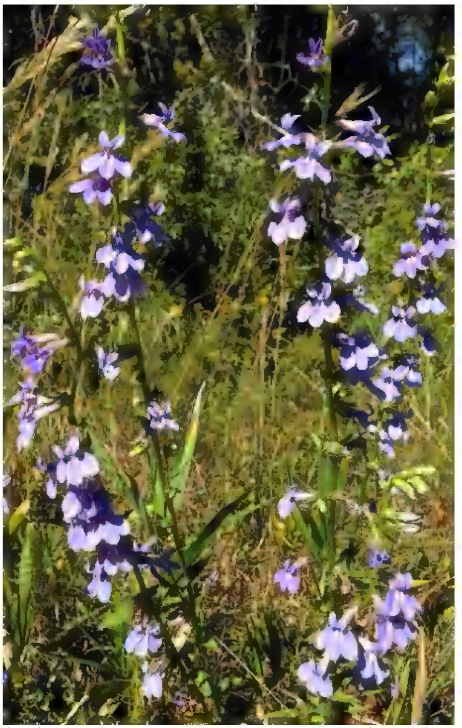
(15f) Form with scattered, tiny teeth on calyx lobes.

Figure 15. *Lobelia georgiana*. (a–c) Geneva Co., Alabama, 1 Oct 2014. Photos: Wayne Barger. (d) Barbour Co., Alabama, 10 Oct 2014. Photo: Wayne Barger. (e & f) Cleburne Co., Alabama, pond margin, 12 Oct 2014. Photos: Dan Spaulding.

10. Lobelia apalachicolensis Spaulding, Barger, & Horne {of Apalachicola} — APALACHICOLA LOBELIA (Fig. 16). Perennial herb. Roadside ditches, wet pine flatwoods, and margins of shrub bogs; September–November. This new species is only known from four counties in the Apalachicola region of the Florida Panhandle (Franklin Liberty, Leon, and Wakulla counties). *Lobelia apalachicolensis* was first collected on October 16, 1954, by Robert K. Godfrey in Liberty Co., Florida from a moist ditch bordering wet woodlands. Dr. Godfrey had identified his specimen as *L. glandulifera* [=*L. georgiana*]. During this study, nine different collections of *L. apalachicolensis* were examined and most were originally determined as *L. georgiana* or *L. glandulosa*. *Lobelia apalachicolensis* is very similar to *L. georgiana* because both species have toothed calyx lobes, lack auricles, and have elliptic-ovate leaves. However, the lower lip of the corolla of *L. apalachicolensis* is distinctly pubescent basally, and in *L. georgiana* it is glabrous to minutely papillate basally. Another species, *L. glandulosa*, is also villous at the base of the corolla lip, but differs by its linear to lanceolate leaves and usually darkens when its dried; whereas *L. apalachicolensis* has elliptical-ovate leaves and dries light green. *Lobelia apalachicolensis* can also be mistaken for individuals of *L. puberula* with toothed calyx lobes, but *L. puberula* has densely pubescent stems, corollas, and calyx lobes.



(16a) Roadside ditch habitat.



(16b) Inflorescence often partially one-sided (secund).

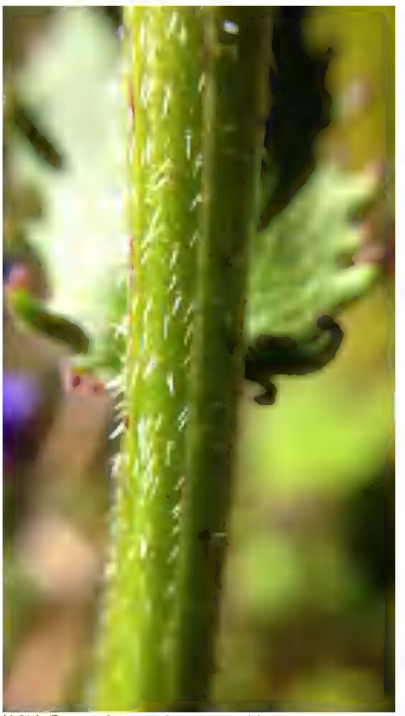
(16c) Close-up of flowers.

(16d) Distinctly pubescent lower lip of corolla near throat of tube.

(16e) Form with glabrous calyx tube and pedicel (the corolla tube will also be glabrous).

(16f) Form with densely pubescent calyx tube and pedicel (it can also be sparsely chaffy-hirsute).

(16g) Corolla tube is occasionally sparsely pubescent in lines (the calyx tube will usually be densely hirsute).



(16h) Stem often with scattered hairs.

(16i) Stem sometimes glabrous or essentially so.

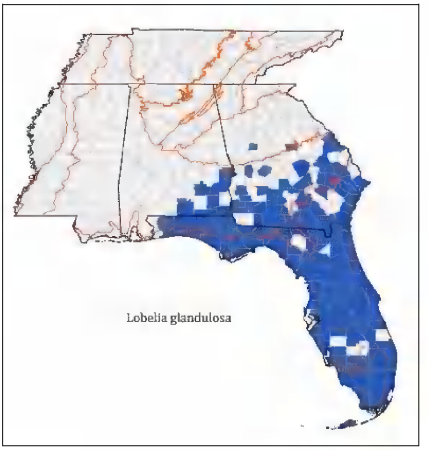
(16j) Leaves ovate to elliptic.

(16k) Sometimes branched below inflorescence.

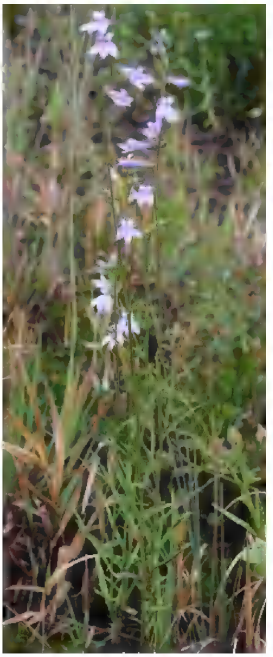
(16l) Most plants over a meter tall (Dan Spaulding 1.88 m = 6' 2").

Figure 17. *Lobelia apalachicolensis.* (a–i) Liberty Co., Florida, roadside ditch, 18 Oct 2014. (j–l) Wakulla Co., Florida, roadside ditch, 19 Oct 2014. Photos by Dan Spaulding & Melanie Taylor.

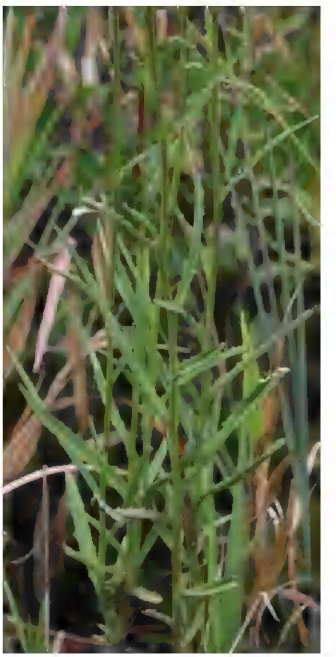
11. Lobelia glandulosa Walt. {glandular} — GLADE LOBELIA; GLANDULAR LOBELIA (Fig. 17).

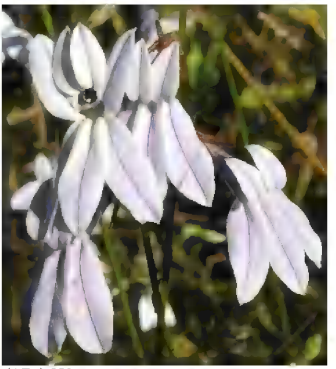


Perennial herb. Seepage slopes, bogs, ditches, roadside seeps, wet pine savannas, and flatwoods; August–November. Found chiefly on the Coastal Plain, rarely adjacent Piedmont, of North Carolina, Georgia, Florida, and southeast Alabama. This species is sometimes mistaken for *L. flaccidifolia*, but *L. glandulosa* has tiny bracteoles at the base of the petiole (Fig. 17h) rather than conspicuous ones near the middle (Fig. 18e). *Lobelia glandulosa* usually has zigzag stems and sharp-tipped leaves that are prominently denticulate with glandular teeth. The calyx lobes of *L. glandulosa* are usually toothed but they are sometimes entire. Its calyx tube is often hirsute, but not short-pubescent like in *L. flaccidifolia* (both species can have a glabrous calyx). Specimens of *L. glandulosa* that lack hair on the calyx tube were named by Fernald (1947) as var. *laevicalyx*, which can be confused with *L. elongata*, but the corolla lip of *L. glandulosa* is densely pubescent basally near throat of tube. A new species, yet to be described, occurs in the Sandhill region of North and South Carolina inhabiting wet streamheads and seepage slopes (Sorrie 2011). This "Sandhills Lobelia" is similar to *L. glandulosa* except that it lacks hair on the lower lip of its corolla. [*Lobelia glandulosa* var. *laevicalyx* Fernald]


(17a) Whole plant.

(17b) Inflorescence.


(17c) Narrow lanceolate leaves.



(17d) White form with purple veins.

(17e) "Laevicalyx" form with no hair on warty calyx tube.

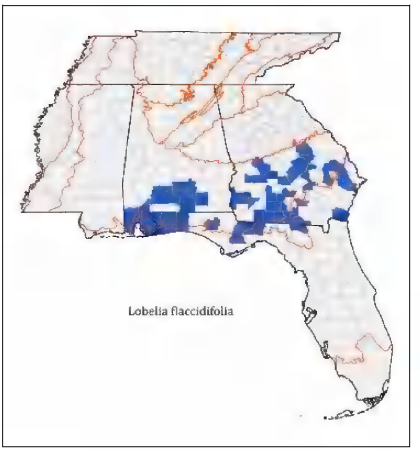
(17f) Lower lip densely pubescent basally.

(17g) Typical form with hirsute calyx tube.

(17h) Bracteole is small and near base of pedicel.

Figure 17. *Lobelia glandulosa*. (a–c) Houston Co., Alabama, 18 Oct 2011. Photos: Wayne Barger. (d & e) Calhoun Co., Florida, 18 Oct 2014. Photos: Dan Spaulding & Melanie Taylor. (f & g) Wakulla Co., Florida, 19 Oct 2014. Photos: Dan Spaulding. (h) Barger & Holt SP#342 (AMAL), Houston Co., Alabama, 18 Oct 2011.

12. Lobelia flaccidifolia Small {flaccid-leaf} — FOLD-EAR LOBELIA (Fig. 18). Annual herb. Bogs, ditches, wet prairies, flatwoods, and floodplain forests; June–August. Native along the Coastal Plain of Georgia through northern Florida west to eastern Texas, but not known from Mississippi (Kartesz 2016). Small (1903) named the disjunct populations in Louisiana and Texas *L. halei,* which he described as having thicker leaves, larger flowers, and unbranched stems. McVaugh (1936) at first recognized *L. halei,* although he wrote: "There is some evidence to show that this species and the next are the same, and intergrade freely. However, *L. flaccidifolia* differs by the thinner, more oblong leaves, greater tendency to branch, smaller and more numerous flowers, and a somewhat later flowering period; in view of these differences, it seems best to keep them as separate species, at least until more material is seen." Eventually, McVaugh (1943) decided not to recognize *L. halei.* Another species, *L. glandulosa* is often confused with is *L. flaccidifolia*, especially the thick-leaved "*halei*" form that has acute tips (the typical species has leaves with blunt tips). The most reliable way to separate these two species is by their bracteoles. *Lobelia flaccidifolia* has two conspicuous, linear bracteoles that are borne near the middle of the pedicel (Fig. 18e), whereas *L. glandulosa* has tiny, oval bracteoles borne at the base of the pedicel and often hidden by the bract (Fig. 17h). If hair is present on the calyx of either species, then they can be easily separated by the type of pubescence. *Lobelia flaccidifolia* will have short, bristly hairs and *L. glandulosa* will have long, chaffy hairs. [*Lobelia halei* Small]



(18a) Whole plant.

(18b) Flower with pubescent lower corolla lip.

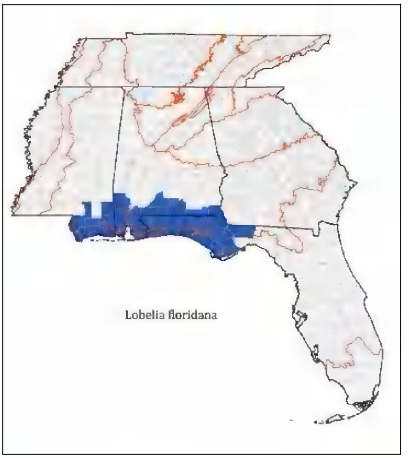
(18c) Close-up of flower clusters; note toothed calyx lobes.

(18d) Oblong leaves of typical form.

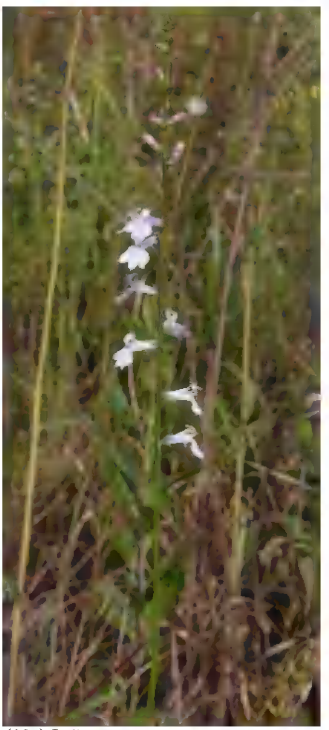
(18e) Bracteoles and short-pubescent calyx.

Figure 18. *Lobelia flaccidifolia.* (a–d) Escambia Co., Florida, 24 Aug 2003. Photos by Kim Davis & Mike Stangeland. (e) *Diamond 16460* (AMAL), Crenshaw Co., Alabama, 2 Jun 2006.

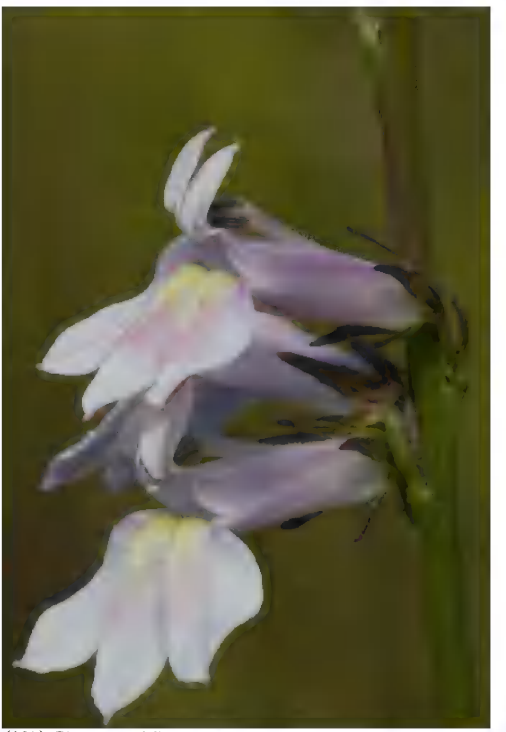
13. Lobelia floridana Chapm. {of Florida} — FLORIDA LOBELIA (Fig. 19). Perennial herb. Bogs, wet pine savannas, and flatwoods; May–October. Occurs on Gulf Coast from eastern Louisiana to the Florida Panhandle. A specimen cited by McVaugh (1936) for New Hanover Co., North Carolina, is probably misidentified. *Lobelia floridana* is very similar to *L. paludosa*, but it is usually more robust. It is typically a taller plant averaging 80–100 cm tall with longer basal leaves (10–30 cm); larger flowers (12–20 mm long, avg. 15–16 mm); and has longer filament tubes (6–11 mm long). Both species have reduced upper leaves with larger ones that are chiefly basal. The key distinguishing features separating it from *L. paludosa* are small auricles (Fig. 19c); a corolla that is not fenestrate (lacks slit-like openings on each side of the tube); and pedicels with small bracteoles at their bases (*L. paludosa* lacks them). Note: Older flowers can be torn and appear fenestrate and auricles can be disappear when plant is in fruit.



[*Lobelia paludosa* Nuttall var. *floridana* (Chapm.) A. Gray]



(19a) Inflorescence.



(19b) Close-up of flowers.

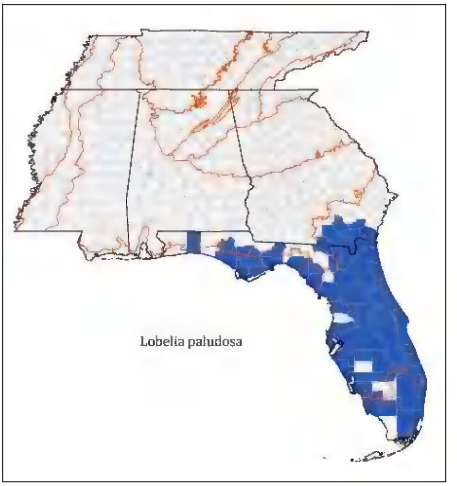
(19c) Calyx with small auricles.

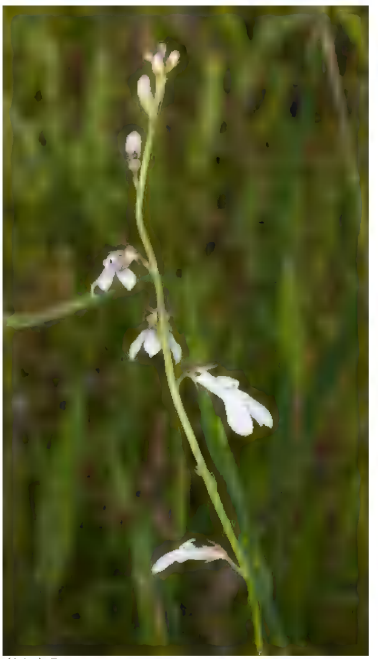
(19d) Reduced upper leaves.

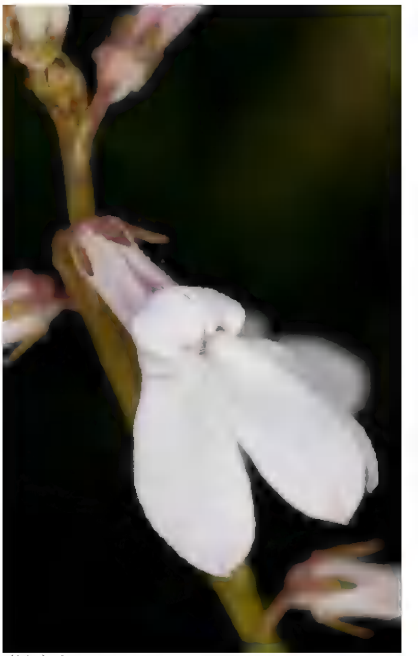
(19e) Larger basal leaves (growing in water).

Figure 19. *Lobelia floridana.* (a–e) Jackson Co., Mississippi, Grand Bay Wildlife Refuge, 27 Sep 2009. Photos: John R. Gwaltney. <www.southeasternflora.com>

14. Lobelia paludosa Nutt. {of bogs} — WHITE LOBELIA; SWAMP LOBELIA (Fig. 20). Perennial herb. Flatwoods, savannas, ditches, and dune swales; April–November. This species is found mostly in Florida, but ranges into adjacent southeast Georgia. *Lobelia paludosa* was erroneously reported for Alabama by Mohr (1901) and Kral et al. (2011), but all specimens determined as *L. paludosa* from Alabama were annotated to *L. floridana* by the senior author. *Lobelia paludosa* does resemble *L. floridana* because both species have leaves that are chiefly basal and strap-like, but *L. paludosa* is not as robust. Most plants average 50–60 cm tall, have smaller flowers (10–16 mm long, avg. 12–13 mm), and shorter filament tubes (3–4.5 mm long). McVaugh (1943) wrote that "In habit and vegetative characters hardly separable from *L. floridana*, but smaller." The key characters of *L. paludosa* are a calyx with no auricles (if calyx surface is pustular it may be more difficult to discern); pedicels that lacks bracteoles; and a fenestrate corolla tube. The fenestrate corollas are more easily seen on dried specimens and are more difficult to detect when flowers are fresh.




(20a) Inflorescence.


(20b) Close-up of flower.

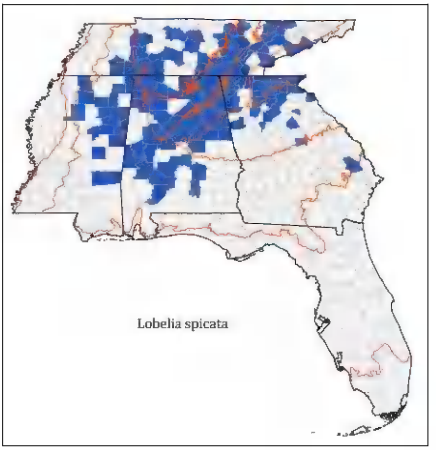
(20c) Calyx lacking auricles.

(20d) Upper, reduced leaf.

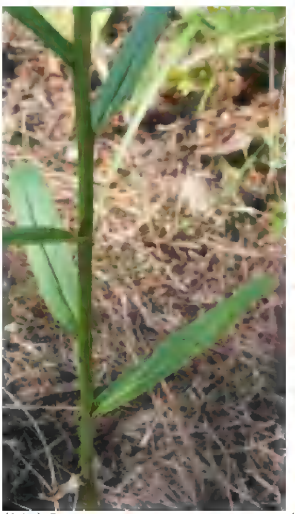
(20e) Larger basal leaves.

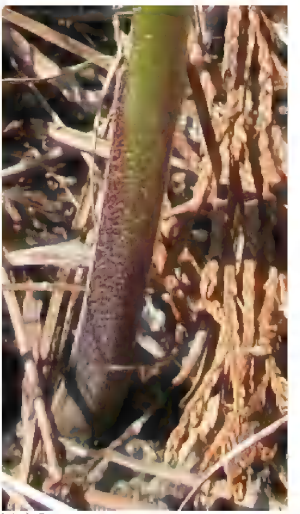
Figure. 20. *Lobelia paludosa*. (a–e) Franklin Co., Florida, Apalachicola National Forest, 2 May 2015. Photos: John R. Gwaltney <www.southeasternflora.com>

15. Lobelia spicata Lam. {spiked} — PALE-SPIKE LOBELIA (Fig. 21). Perennial herb. Open woods, fields, prairies, roadsides, rocky hillsides, creek banks, glades, and barrens; June–August. Native to midwestern and eastern USA and adjacent Canada. In the USA this species ranges from eastern Montana to Maine, south to Georgia and west to East Texas (Kartesz 2016). The common name, Pale-Spike Lobelia, was given because the flowers are often white, but they can sometimes be blue. *Lobelia spicata* is a highly variable taxon and is actually one polymorphic species. The characters used to separate various varieties, listed in McVaugh (1936), intergrade within populations, making these infraspecific taxa arbitrary. The most common variety in the Deep South (var. *leptostachya*) often has filiform auricles with knobbed tips (Fig. 21f), but in some individuals these auricles are not well-developed and the plants resemble the typical variety (var. *spicata*), which usually lacks auricles. One variety has larger basal leaves and smaller cauline leaves (var. *scaposa*) and another variety has strongly rough-pubescent stems and calyx lobes (var. *hirtella*). But all of these characters are variable from one plant to the next and many specimens cannot be reliably keyed out to any variety. One of McVaugh's varieties (var. *campanulata*) was distinguished by its white anthers, but was excluded by Bowden (1959) because it was male-sterile. [*Lobelia leptostachys* A. DC.; *L. spicata* var. *campanulata* McVaugh; *L. spicata* var. *hirtella* A. Gray; *L. spicata* var. *leptostachys* (A. DC.) Mack. & Bush; *L. spicata* var. *scaposa* McVaugh]



(21a) Spike-like inflorescence.

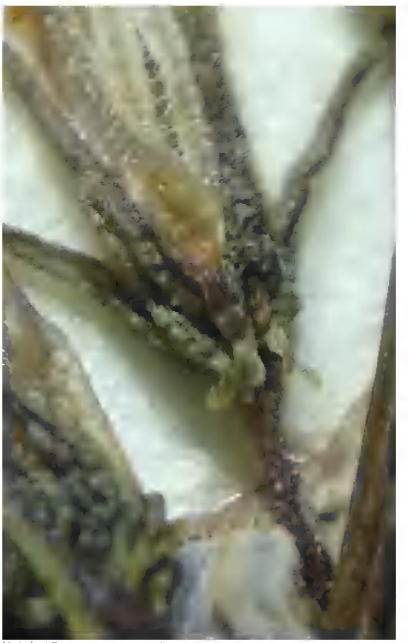

(21b) Leaves are often oblong.


(21c) Lower stem densely puberulent.

NORTH CAROLINA
PERSON COUNTY. US 501 & Flat Creek, s. of Roxboro. Roadside & slope along creek.
T. A. Atkinson 1568
R. D. Whetstone
2 June 1976
ANNISTON MUSEUM OF NATURAL HISTORY (AMAE)
Lobelia spicata Lam.
[Polymorphic species; varieties not worthy of recognition]
det. Daniel D. Spaulding December 2014
ANNISTON MUSEUM OF NATURAL HISTORY
Lobelia spicata Lam. var. scaposa McVaugh
det. Daniel D. Spaulding December 2011

(21d) "Scaposa" form with larger basal leaves and decreasingly smaller cauline leaves.

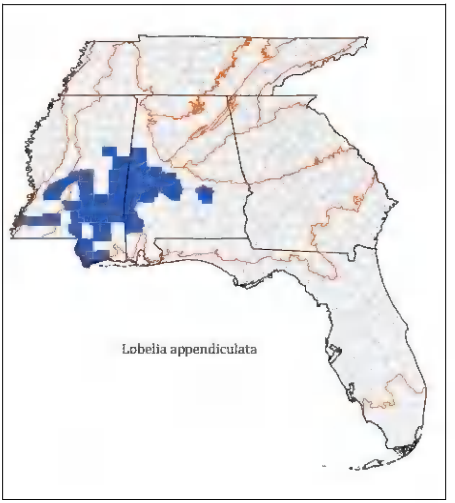
(21e) "Hirtella" form with scabrous calyx.



(21f) "Leptostachya" form with long auricles.

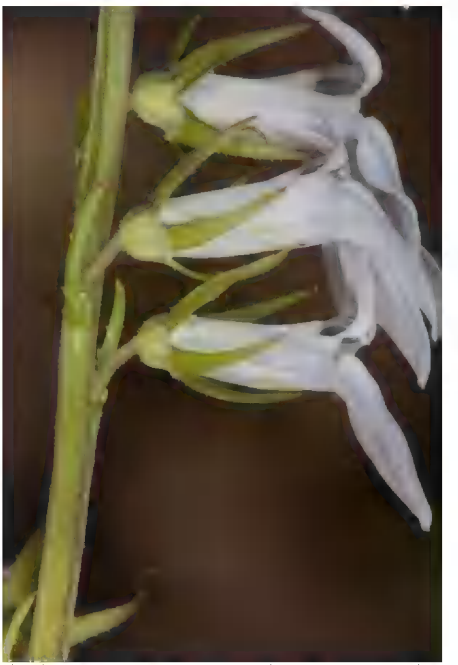
Figure 21. *Lobelia spicata*. (a–c) DeKalb Co., Alabama, Limestone barren, 16 Aug 2014. Photos: Dan Spaulding. (d) *Atkinson & Whetstone 1568* (JSU), Pearson Co., North Carolina, 2 Jun 1976. (e) *Sharp & Underwood 157* (TENN), Campbell Co., Tennessee, 4 Jul 1933. (f) *Spaulding et al. 13819* (AMAL), Calhoun Co., Alabama, 1 Aug 2013.

16. Lobelia appendiculata DC. {appendaged} — PALE LOBELIA; EAR-FLOWER LOBELIA (Fig. 22).



Annual or biennial herb. Roadsides, fields, prairies, and grassy openings in woods; May–July. This species is found in the Black Belt region of Mississippi and Alabama, but ranges west to east Texas and north to southeast Kansas. The epicenter of this species is the lower Midwest (Kartesz 2016). McVaugh (1936) reported this species from Hancock Co., Illinois, but it's likely an error. The corolla of Pale Lobelia is frequently white, but they are also sometimes blue. *Lobelia appendiculata* is often misidentified as *L. spicata*, but can be easily distinguished by its short-ciliate margined calyx lobes, its tendency to have secondary branches, and its short-ovate leaves with rounded bases. Specimens from Louisiana, Texas and Arkansas have the typical foliaceous auricles and conspicuously ciliate calyx lobes (Fig. 22e). In Mississippi and Alabama, *L. appendiculata* usually has smaller auricles and the calyx lobes are usually not strongly ciliate (Fig. 22c). *Lobelia gattingeri* is similar to *L. appendiculata* but completely lacks auricles and has glabrous calyx lobes.

(22a) Inflorescence mostly secund.



(22b) Close-up of inflorescence (small auricle form).

(22c) Close-up of calyx (small auricled form) with ciliate margined lobes.

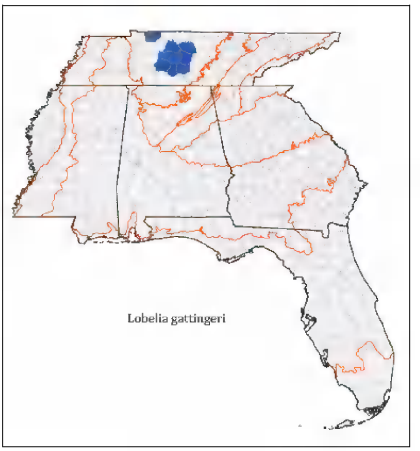
(22d) Leaf bases rounded; stems often branching.

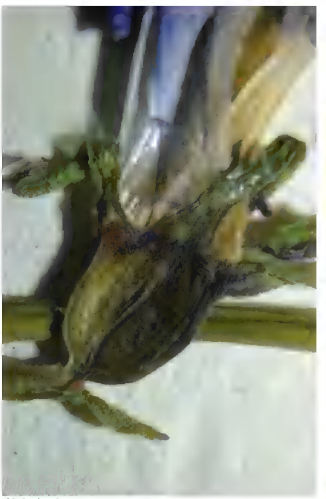
(22e) Large auricle form with strongly ciliate calyx.

(22f) Leaves with irregularly toothed margins.

Figure 22. *Lobelia appendiculata*. (a–d) Rankin Co., Mississippi, 16 Jul 2013. Photos by John R. Gwaltney. <southeasternflora.com> (e & f) *Haynes 10379* (AMAL), Claiborne Parish, Louisiana, 1 Jun 2003.

17. Lobelia gattingeri A. Gray {for pioneer botanist of Tennessee, Augustin Gattinger, 1825-1903} — GATTINGER'S LOBELIA (Fig. 23). Annual herb. Calcareous barrens and cedar glades; late April–early August (peak flowering time is May through June). This species is endemic to the Interior Low Plateau Province and is only known from eight counties in Tennessee and, according to Kartesz (2016), two counties in Kentucky. Baskin & Baskin (1979) observed that plants tend to vary greatly in size even in the same population (7.5 to 38 cm in height). They state that "since a population usually consists of plants behaving as winter annuals as well as summer annuals, and perhaps occasionally as biennials, there are large differences in sizes of flowering plants." It is the larger plants that usually have one or more secondary branches (Fig. 23c). This species is very similar to *L. appendiculata*, but differs by lacking auricles and having no cilia on its calyx lobes (Fig. 23a). McVaugh (1936) stated that "due to the very restricted range of the latter, and the fact that relatively few intermediate plants have been seen, it seems best for the present to maintain both as good species," but later McVaugh (1943) reduced *L. gattingeri* to a variety of *L. appendiculata*. Bowden (1959a) said that "specimens of *L. gattingeri* have distinctive morphological characteristics and I regard the taxon as a species." The inflorescence of both species have racemes that are partially secund, which means flowers are borne mostly on one side of the flowering stalk (Fig. 19d). In a similar species, *L. spicata*, the inflorescence is spike-like and the flowers are borne on all sides. Mohr (1901) erroneously reported *L. gattingeri* from Alabama, yet it is possible that this species may one day be found in limestone glades of north Alabama. [*Lobelia appendiculata* A. DC. var. *gattingeri* (A. Gray) McVaugh]




(23a) Calyx lacking auricles and cilia.

(23b) Leaf base semi-clasping and secondary branch from leaf axil.

(23c) Herbarium specimen showing secondary branching.

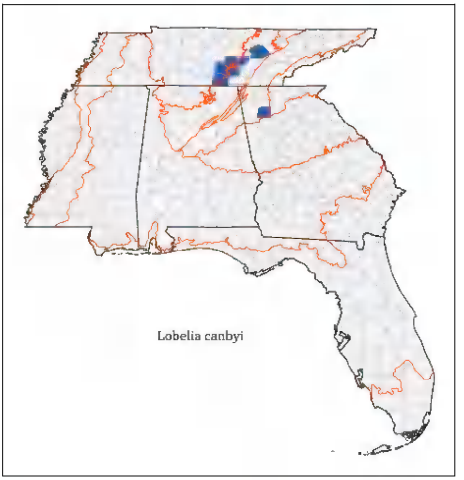
(23d) Inflorescence secund.

(23e) Close-up of flowers.

(23f) Leaf bases rounded.

Figure 23. *Lobelia gattingeri*. (a–c) *Kral 84796* (BRIT), limestone glade, Wilson Co., Tennessee. (d–f) Bedford Co., Tennessee, Limestone glade, 11 May 2014. Photos by Jack Carmen.

18. Lobelia canbyi A. Gray {for its discoverer, Delaware botanist William Canby, 1831-1904} — CANBY'S LOBELIA (Fig. 24). Perennial herb. Sandy swamps, wet barrens, pine savannahs, limesink ponds, cypress-gum ponds, Carolina bays, and pocosins; July–November (peak flowering time is in August and September). Native on the Atlantic Coastal Plain from New Jersey to Georgia and disjunct in the mountains in a few counties of Tennessee, Georgia, and North Carolina. A report from Thomas Co. in southwest Georgia (Kartesz 2016) was in error and the specimen was annotated to *L. nuttallii*. *Lobelia canbyi* resembles *L. nuttallii,* but *L. canbyi* is strongly antrorsely scabrid on its pedicels and calyx. The lower corolla lip of Canby's Lobelia is also always pubescent at the base near the throat, while *L. nuttallii* has a completely glabrous corolla lip. *Lobelia canbyi* has not been collected in Alabama, but occurs in adjacent Franklin Co., Tennessee. *Lobelia boykinii* is also similar but has subulate-filiform leaves, rhizomes, and a glabrous calyx.



(24a) Narrow leaves.

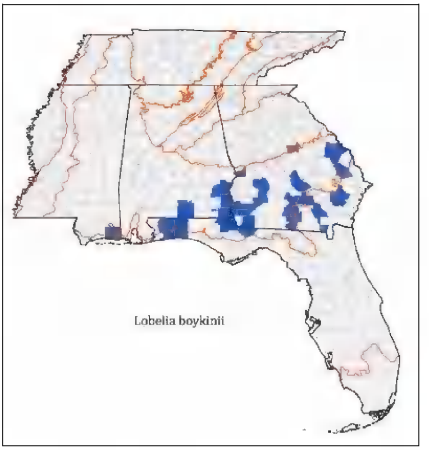
(24b) Close-up of inflorescence.

(24c) Lower lip of corolla pubescent at throat.

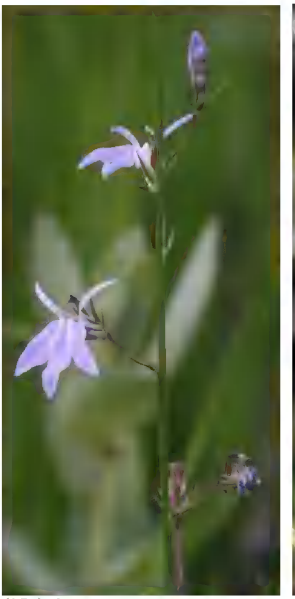
(24d) Calyx antrorsely scabrous.

Figure 24. *Lobelia canbyi.* (a & b) Coffee Co., Tennessee, 20 Jul 1985. Photos: Jack Carmen. (c & d) Craven Co., North Carolina, 27 Aug 2006. Photos: Jeffrey S. Pippen. <www.jeffpippen.com>

19. Lobelia boykinii Torrey & A. Gray ex DC. {for its discoverer, Samuel Boykin, 1786–1848} — BOYKIN'S LOBELIA (Fig. 25). Rhizomatous, perennial herb. Wet depressions, herbaceous wetlands, sloughs, bogs, pineland swamps, and cypress ponds; May–early August. Endemic to the Atlantic and Gulf Coastal Plain. Disjunct in New Jersey and Delaware, then ranges from North Carolina southward through the Florida Panhandle to Mississippi. There is a report from New Hampshire (Center for Plant Conservation 2006), but this record has not been confirmed and is likely erroneous. Royo et al. (2008) reported that the degradation of non-alluvial coastal plain wetlands in the eastern USA has contributed to the decline of *L. boykinii*, which is now listed globally as critically imperiled (G2). While many lobelias are found in wetlands, *L. boykinii* is an obligate wetland plant and truly aquatic. Seeds germinate in late summer and develop rosettes that usually over winter in standing water (McAvoy & Wilson 2014). Diagnostic characters of this species are subulate-filiform leaves, rhizomes, and often spongy-thickened bases of stems.



(25a) Aquatic habit

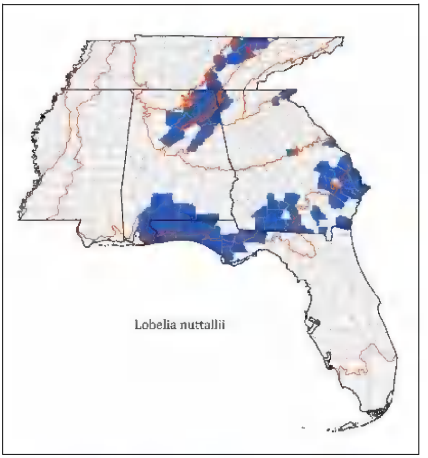


(25b) Close-up of flowers

(25c) subulate leaves

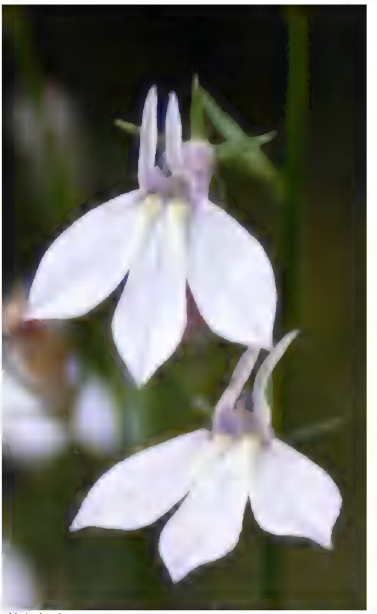
Figure 25. *Lobelia boykinii.* (a) Sussex Co., Delaware, coastal plain pond, 25 Jul 2013. Photos by Ronald Wilson. (b) Henry Co., Alabama, open wet depression, 16 May 2012. Photo by Wayne Barger. (c) Henry Co., Alabama, open wet depression, 5 May 2011. Photo by Wayne Barger.

20. Lobelia nuttallii J.A. Schultes {for its discoverer, English botanist Thomas Nuttall, 1786–1859} — NUTTALL'S LOBELIA (Fig. 26). Perennial herb. Bogs, ditches, wet pine savannas, flatwoods, seeps, and depressions in sandstone outcrops; April–October (peaks May–August). Nuttall's Lobelia is native to the eastern USA from New York south to Alabama (Kartesz 2016). This species occurs on the Coastal Plain, with disjunct populations in the Appalachians. *Lobelia kalmii* is similar, but has bracteoles borne near the middle of the pedicel rather that at the base. *Lobelia kalmii* occurs in calcareous swamps in northern USA and adjacent Canada (Kartesz 2016). *Lobelia canbyi* is also often confused with *L. nuttallii.* Both taxa have narrow leaves and small flowers, but *L. nuttallii* differs by having no hair on lower lip of its corolla (Fig. 26c); pedicels that are glabrous or with bristly hairs (Fig 26d); and basal leaves that are wider than cauline leaves (Fig. 26e).

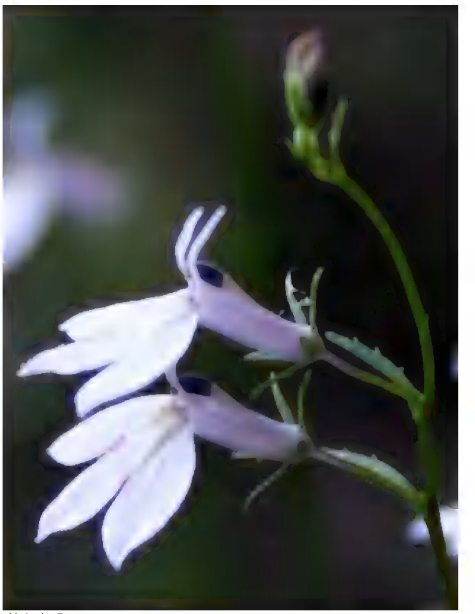


(26a) Inflorescence.

(26b) Cauline leaves are narrow.



(26c) Corolla with smooth lower lip.



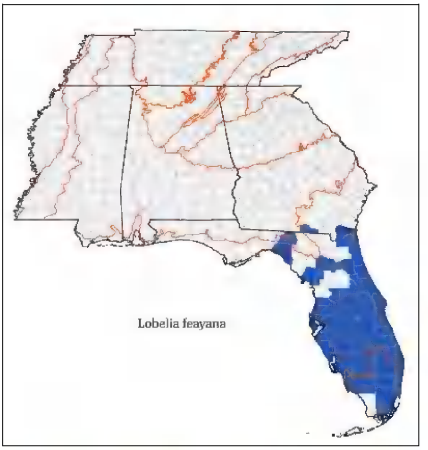
(26d) Side view of flowers.

(26e) Broad basal leaves.

(26f) Calyx tube with bristly hairs (also glabrous).

Figure 26. *Lobelia nuttallii*. (a) DeKalb Co., Alabama, sandstone glade, 23 Jul 2014. Photo by Jack Carmen. (b–d) Etowah Co., Alabama, seepage bog, 24 Sep 2014. Photos by Wayne Barger. (e) *Kral 91178* (AMAL), Monroe Co., Alabama, 27 May 2001. (f) *Kral 94039* (AMAL), Grady Co., Georgia, 12 May 2003.

21. Lobelia feayana A. Gray {in honor of physician and botanist, William T. Féay (1803–1879), of Savannah, Georgia} — BAY LOBELIA, FEAY'S LOBELIA (Fig. 27). Annual herb. Ditches, low roadsides, moist lawns, swales in dunes, and wet pine savannas; December–May (peak flowering time is February through April). This taxon has long been thought to be endemic to Florida but a collection was made by Vernon E. McNeilus from Echols County, Georgia in 1992 (housed at TENN). *Lobelia feayana* is the only decumbent species in the southeast and it is easily recognized by its distinct suborbicular leaves with obvious petioles (Fig. 24d) and small bluish-purple flowers. McVaugh (1936) said that "this species is very close to *L. nuttallii*, from which it differs by the weaker shorter stems, usually roundish lower leaves, general smoothness, including pedicel and calyx (in contrast to *L. nuttallii*, which is often prickly), and the more elongate calyx."



(27a) Photo: Mary Keim

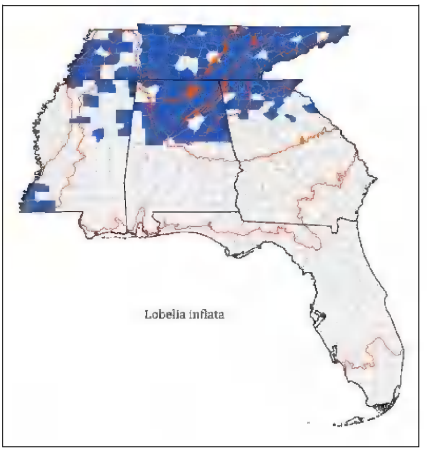
(27b) Photo: Mary Keim

(27c) Photo: Wayne Matchett

(27d) Photo: Bob Upcavage

Figure 27. *Lobelia feayana*. (a & b) Orange Co., Florida, Orlando Wetlands Park, 10 Mar 2012. (c) Orange Co., Florida, Tosohatchee WMA, 9 Apr 2016. (d) Orbicular leaves with petioles, south Florida, 29 Jul 2009.

22. Lobelia inflata L. {inflated} — INDIAN-TOBACCO; INFLATED LOBELIA; PUKE-WEED; VOMIT-WEED (Fig. 28). Annual or biennial herb. Roadsides, pastures, fields, open woods, and disturbed areas; June–November. *Lobelia inflata* is native to eastern North America, from southeastern Canada south through the eastern USA west to Kansas (Kartesz 2016). The only state *L. inflata* has not been collected from in the eastern USA is Florida. This species is easily identified by its shaggy-haired stems and small flowers with a calyx that becomes swollen (inflated) in fruit. Native Americans were reported to have used the plant as a tobacco substitute (Shosteck 1974), hence the common name. Indian-tobacco acts as a narcotic and was used medicinally to treat lung ailments, but also was popular with members of the counterculture who smoked it or brewed it into a tea to get high (Dobelis 1986). Deaths have been reported from overdoses, and symptoms include nausea, vomiting, headache, collapse, and convulsions (Kingsbury 1964). [*Lobelia inflata* var. *simplex* (Raf.) Millsp.]



(28a) Plant with basal branches.

(28b) Small flowers & inflated fruit.

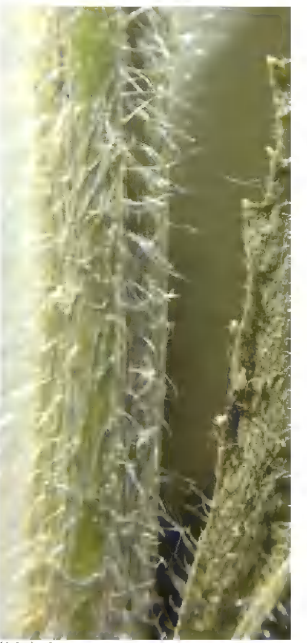
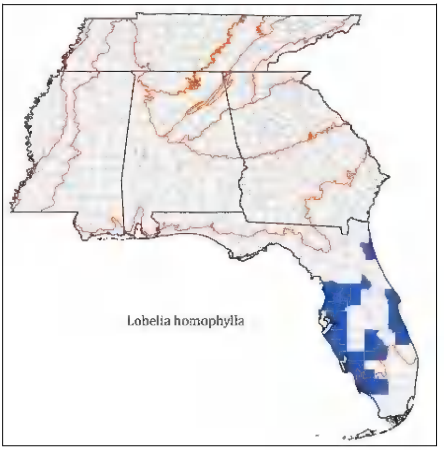

(28c) Close-up of shaggy stem.

Figure 28. *Lobelia inflata.* (a & b) Jackson, Co., Alabama, woodland border, 3 Jul 2007. Photos: Wayne Barger. (c) *Keener 1151* (AMAL), disturbed area on edge of woods, Blount Co., Alabama, 3 Jul 1998.

23. Lobelia homophylla F.E. Wimm. {with one kind of leaf} — PINELAND LOBELIA (Fig. 29).



Annual herb. Bottomland forests, hardwood hammocks, floodplains, pine flatwoods, river banks, low roadsides, moist grassy areas, and ruderal sites; February–November (flowers most often in March and April). *Lobelia homophylla* is endemic to peninsular Florida. This species has small, bluish-purple, non-fenestrate corollas. Another annual from Florida, *L. feayana*, is sometime mistaken for Pineland Lobelia because both species have leaves with long petioles, but *L. homophylla* can be distinguished by its upright stems and ovate leaves with crenate, coarsely toothed or incised margins. *Lobelia homophylla* has also been misidentified as *L. cliffortiana* L., which is native only to Cuba, Hispaniola, and Jamaica (McVaugh 1940). Rosatti (1986) said that *L. cliffortiana* "is very similar to *L. homophylla* but differs in its sometimes lanceolate or elliptic upper leaves, usually larger flowers, and more-than-half-inferior capsules." *Lobelia homophylla* has capsules that are nearly superior. Ward (1978) stated that *L. cliffortiana*, a native of the New World Tropics, "has been attributed to Florida apparently on the basis of confusion with the very similar *L. homophylla*." Small (1933) reported *L. cliffortiana* as a weed in wet places, waste places, and cultivated ground on the Coastal Plain from Florida to Texas, but this report is most likely in error since no specimens have been seen in the USA.

Figure 29. *Lobelia homophylla.* Manatee Co., Florida, 1 Mar 2003. Photos by Jason Sharp.

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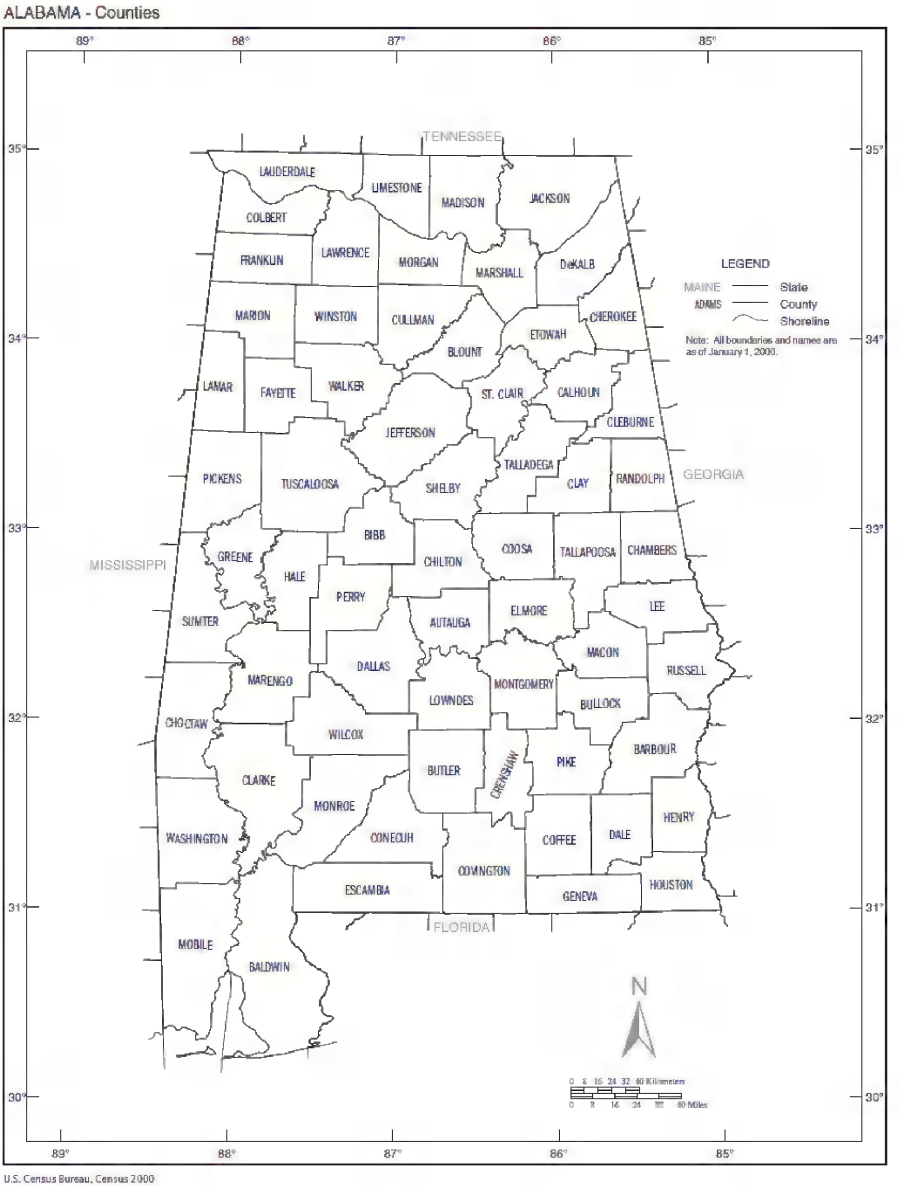
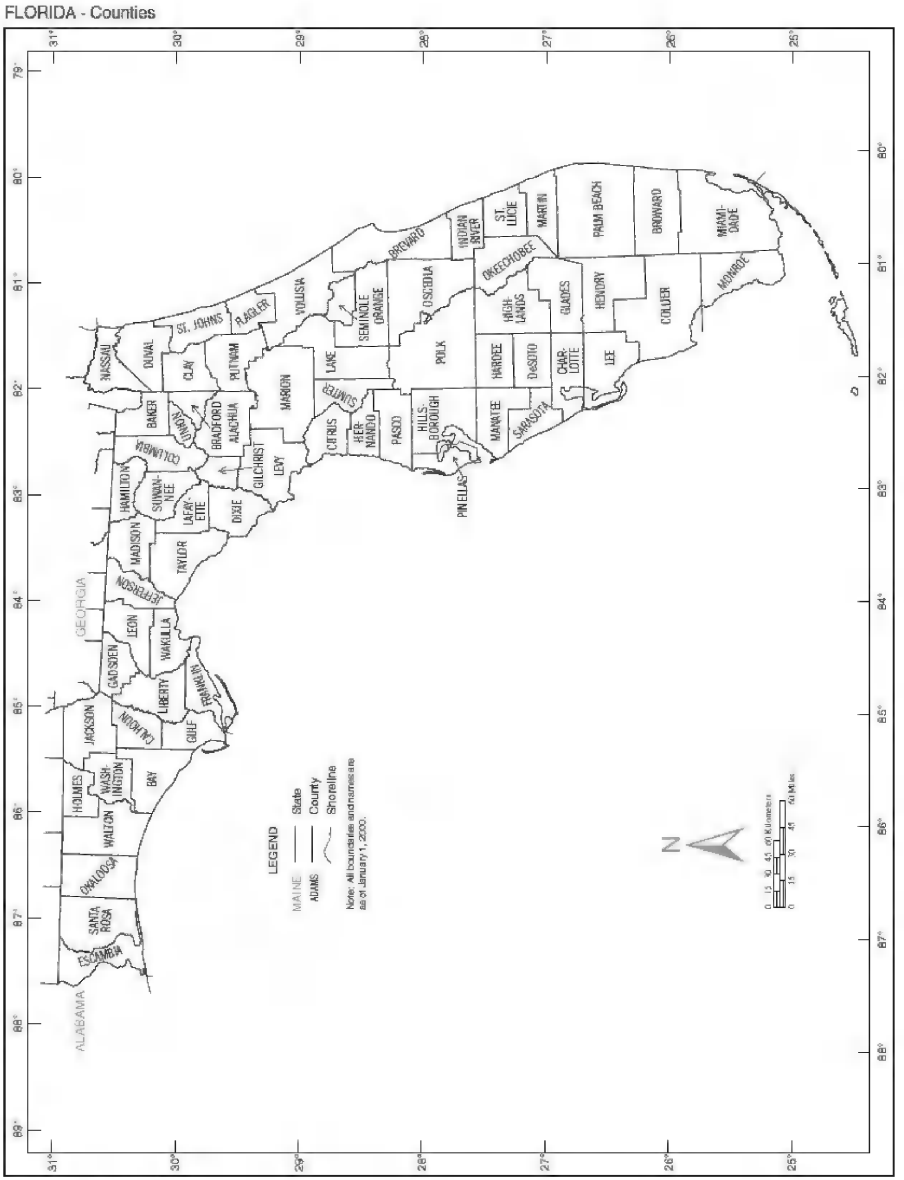
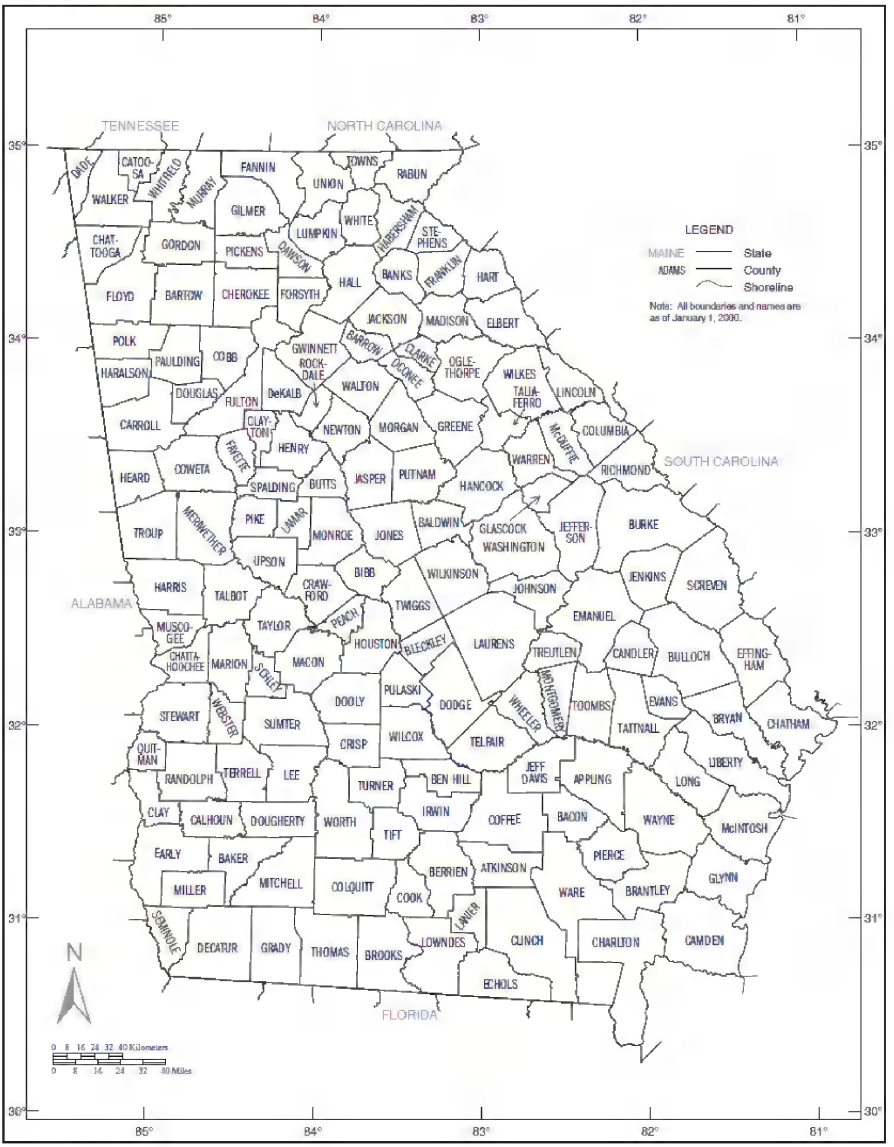
APPENDIX A: County Maps of Alabama, Florida, Georgia, Mississippi, and Tennessee.




FLORIDA - Counties
LEGEND
State
County
Shoreline
Note: All boundaries and names are as of January 1, 2000.
N
ALABAMA
GEORGIA
U.S. Census Bureau, Census 2000

GEORGIA - Counties



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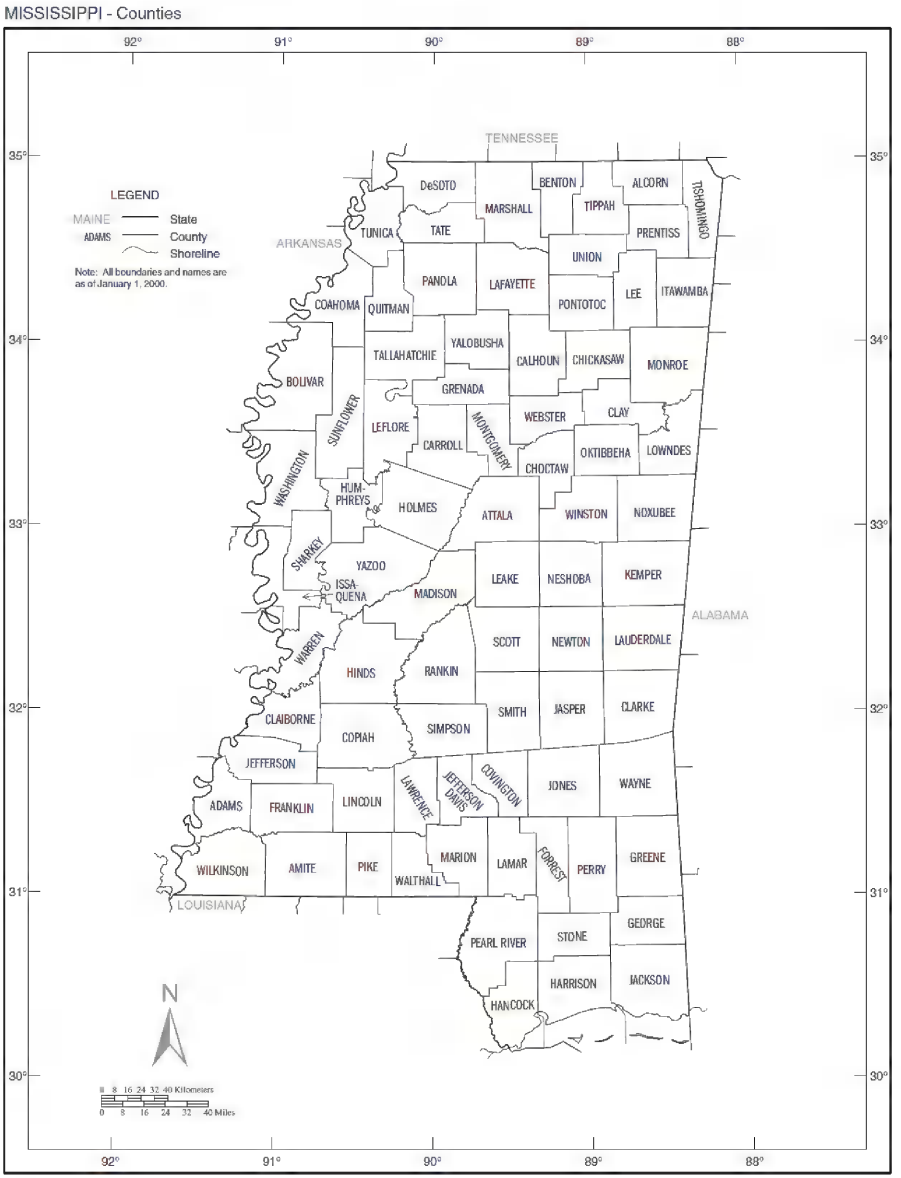

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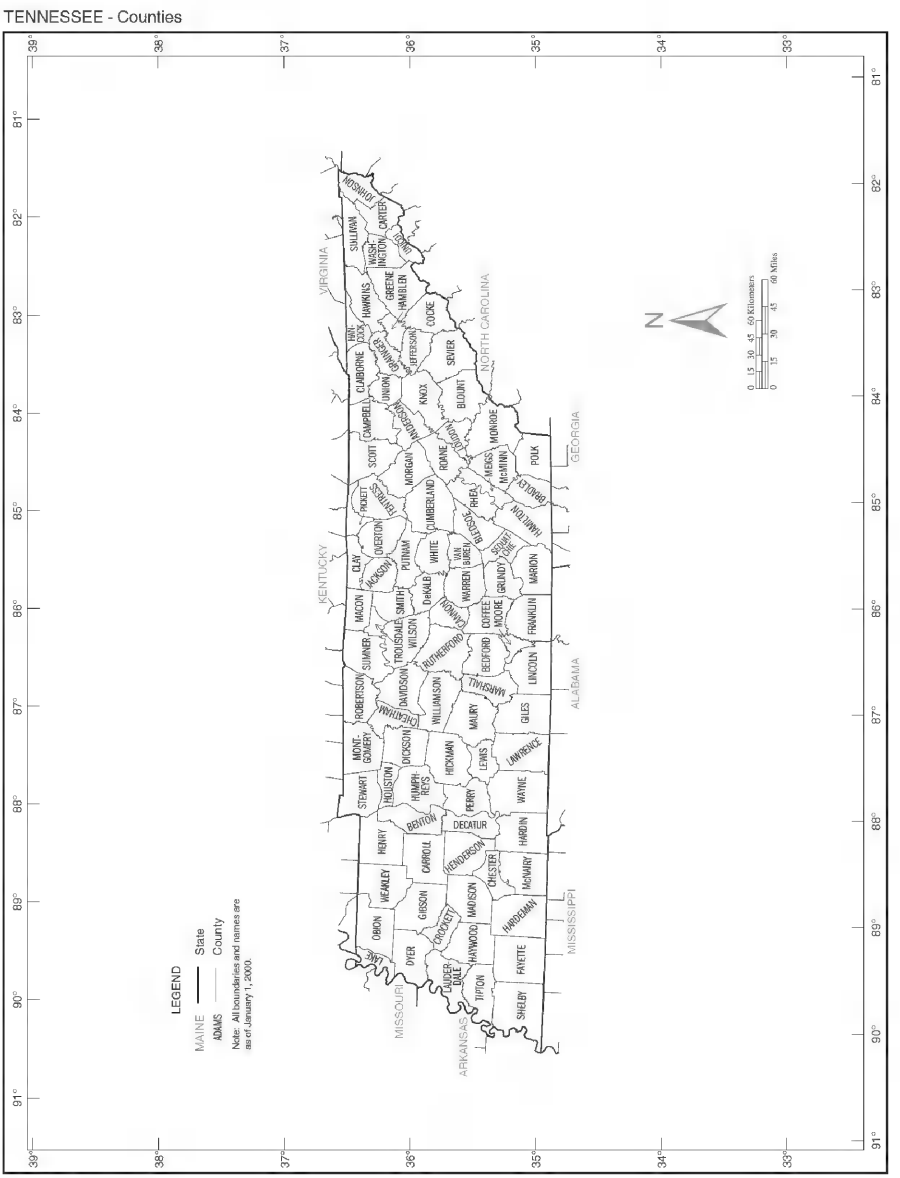
TENNESSEE - Counties
LEGEND
State
County
Note: All boundaries and names are as of January 1, 2000.
U.S. Census Bureau, Census 2000
KENTUCKY
VIRGINIA
NORTH CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
ARKANSAS
MISSOURI
N
0 15 30 45 60 Kilometers
0 15 30 45 60 Miles

Felger, R.S. and S. Rutman. 2016. Ajo Peak to Tinajas Altas: Flora of southwestern Arizona. Part 21. Eudicots: Asteraceae–Aster Family. Phytoneuron 2016-77: 1–164. Published 29 November 2016. ISSN 2153 733X

AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA
Part 21. EUDICOTS: ASTERACEAE – ASTER FAMILY

RICHARD STEPHEN FELGER
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ABSTRACT

A floristic account is provided for the aster or daisy family as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert in southwestern Arizona. This is the largest family in the flora area; the modern flora includes 106 taxa in 65 genera, with only 9 non-native species. The fossil record is rich; at least 30 species are known from fossils, including at least four taxa no longer present in the area. Fifty-seven (59 percent) of the composite taxa are annuals (ephemerals), most of which are cool-season (winter-spring) species. Non-native taxa are remarkably few (9 species; 3 of them are not established as reproducing populations) and none are invasive. This is the twenty-first contribution for this flora series published in Phytoneuron and also open access on the website of the University of Arizona Herbarium (ARIZ).

Asteraceae (comps) and Orchidaceae (orchids) are the two largest families of vascular plants. Comps include about 1620 genera and 25,040 species, or about 9% of the world flora (Stevens 2012). Mexico contains nearly 10% of the world's species of comps and North America north of Mexico has a similar diversity. The family is especially well developed and diverse in semi-arid regions of the world. The worldwide success of the composite family in terms of taxonomic and ecological diversity is due in large part to the evolutionary plasticity of the capitulum (flower head) as a functional flower (Jeffrey 2009) and the highly developed and efficient chemical defenses against herbivores (e.g., Cronquist 1981). Indeed, while studying Sonoran Desert composites one is impressed by the prevalence and diversity of glands on the stems, leaves, and especially youngest growth and exposed surfaces of phyllaries and corollas. These glands occur in combination with a great diversity of hairs (trichomes).

This contribution is the final installment for the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert in southwestern Arizona (Figure 1). The previously published parts are listed on the last page of this publication. The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens. This flora is specimen-based; we have seen nearly all specimens cited.

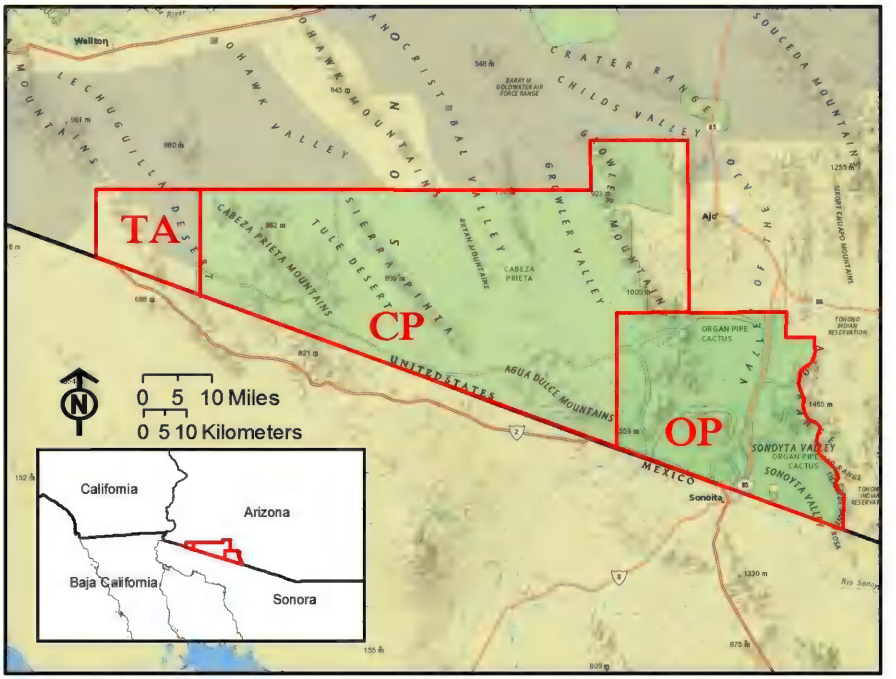

Figure 1. Flora area in southwestern Arizona. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. Green shading indicates approximate boundaries of federally designated wilderness.

Explanation of the format for the flora series is provided in part 3 (Felger et al. 2013b). Vernacular, or common names, when known or deemed worthwhile, are given in English, Spanish (shown in italics), and the Hia-Ced O'odham dialect, respectively. Non-native taxa in the flora area are marked with an asterisk (*) and non-natives not established as reproducing populations are marked with two asterisks (**). Fossil specimens are indicated with a dagger symbol (†) and fossils of taxa no longer present in the flora area are marked with two dagger symbols (††). All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2016). All photos and scans are by Sue Rutman and all line art is by Lucretia Breazeale Hamilton (1908–1986) unless otherwise stated.

Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region. Baja California refers to the northern state and Baja California Sur to the southern state of the peninsula, and Baja California Peninsula refers to both states or when the specific state is not known. The identification keys are for the modern flora; taxa not established as reproducing populations or no longer occurring in the flora area are not included in the keys. Descriptions and keys pertain to taxa and populations as they occur in the flora area.

Asteraceae in Southwestern Arizona

Annuals, herbaceous perennials, and shrubs (elsewhere sometimes vines and small trees). Leaves highly variable, simple but often deeply lobed to highly dissected; stipules none (sometimes with stipule-like leafy appendages at leaf bases, e.g., *Verbesina encelioides*). Individual flowers (florets) usually small, highly variable; bisexual, staminate, or pistillate; pistillate florets either fertile (producing fruit) or sterile (asexual, or neuter, not producing fruit). Florets organized into a head (capitulum) surrounded by bracts (phyllaries) forming the involucre (or phyllaries rarely absent, e.g., *Stylocline*). Heads usually on a peduncle (stem supporting the flower head) with few to many florets. Composites in the flora area as well as the Sonoran Desert Region have four kinds of florets:

1. Disk florets: Corollas tubular, (3- or 4-) 5-lobed, radially symmetric or rarely slightly bilaterally symmetric; usually bisexual or sometimes functionally staminate (the stigma present but fruit not produced). Many comps have only disk florets (discoid heads), e.g., *Baccharis*, *Bebbia*, *Palafoxia*, and *Peucephyllum*; others have disk florets in the center of the flower head and surrounded by ray florets.

2. Ray florets: Corollas with a short tube below a limb, the limb (ray or ligule) strap-shaped (extended on one side, the floret thus bilaterally symmetric) and usually 3-toothed or 3-veined, or rarely the limb greatly reduced or absent (the florets eligulate, e.g., *Erigeron canadensis*). Ray florets pistillate and fertile (producing fruit) or sterile, and surrounding (exterior to) the disk florets: e.g., *Baileya*, *Encelia farinosa,* and *Geraea*.

3. Ligulate florets: Florets bisexual; all florets in the head of the same kind, although the inner ones often smaller, the florets usually numerous in each head. Corollas tubular below, with a 5-toothed limb (ligule or "ray"), the floret thus bilateral: e.g., *Malacothrix*, *Rafinesquia*, *Stephanomeria*, and *Uropappus*.

4. Bilabiate florets: Florets bisexual; all florets in the head of the same kind. Corollas 2-lipped, the inner (toward center) lip 2-lobed, the outer lip 3-lobed, the floret thus bilateral: *Acourtia* and *Trixis*.

Calyx modified as the pappus or sometimes absent. The pappus diverse, often represented by awns, bristles, hairs, or scales, and variously smooth, scabrous, or feathery (plumose). Stamens (4) 5, inserted on the corolla, the anthers usually united around the style, the filaments not fused (filaments fused and anthers separate in *Ambrosia* and *Xanthium*) or stamens absent from unisexual pistillate flowers. Ovary inferior, the style solitary and often ringed at the base by a nectary, the stigma 2-branched. Fruit 1-seeded, referred to here as an achene, although technically a cypsela.

This is the largest family in the flora area as well as the Sonoran Desert and globally. The 106 taxa (Table 1; excluding taxa not established and fossils no longer present) in the modern flora area represent 15% of the total flora, a percentage comparable to that of the flora of adjacent northwestern Sonora (Felger 2000). At least 30 species are known from the fossil record, four of which are known from the flora area only by fossils. Non-native taxa are remarkably few (9 species) and none are invasive. Three of the non-natives are not established as reproducing populations.

Table 1. Local distributions of composite taxa for the flora in southwestern Arizona. † = Modern taxa also represented by a fossil specimen; †† = fossil taxa not found in the modern flora area; * = non-native taxa; ** = non-natives not established (not reproducing) in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. S = Summer/warm-season ephemerals; W = cool-season/winter-spring ephemerals; NS = non-seasonal ephemerals and NS/P = non-seasonal ephemerals sometimes becoming perennials; PR = perennials. Localities and growth forms in parentheses are ones that are rare or seldom found (probably not reproducing), or known only from fossils and not part of the modern flora, and are not counted in the totals.

TAXON	REGION			GROWTH FORM			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals			Perennial
				Summer	Winter	Non-seasonal	
Acamptopappus sphaerocephalus	OP						PR
Acourtia nana	OP						PR
Acourtia wrightii	OP	CP					PR
Adenophyllum porophylloides	OP	CP					PR
Ageratina paupercula	OP						PR
Ambrosia ambrosioides	OP	CP	TA				PR
†*Ambrosia confertiflora*	OP	CP	TA				PR
Ambrosia cordifolia	OP						PR
†*Ambrosia deltoidea*	OP	CP	(TA)				PR
†*Ambrosia dumosa*	OP	CP	TA				PR
Ambrosia dumosa × *A. ilicifolia*			TA				PR
†*Ambrosia ilicifolia*		CP	TA				PR
Ambrosia monogyra	OP	CP					PR
†*Ambrosia salsola*	OP	CP	TA				PR
Artemisia dracunculus	OP						PR
†*Artemisia ludoviciana*	OP		(TA)				PR
(††*Artemisia tridentata*)	(OP)						(PR)
Baccharis brachyphylla	OP	CP	TA				PR
Baccharis salicifolia	OP	CP					PR
Baccharis sarothroides	OP	CP	TA				PR
†*Bahiopsis parishii*	OP	CP	TA				PR
Baileya multiradiata	OP	CP				NS	
Baileya pleniradiata	OP	CP	TA			NS	
†*Bebbia juncea*	OP	CP	TA				PR
†*Brickellia atractyloides*		CP	TA				PR
Brickellia californica	OP						PR
†*Brickellia coulteri*	OP	CP					PR
Brickellia frutescens	OP						PR
(†*Brickellia* sp.)	(OP)						(PR)
(††*Calycoseris parryi*)	(OP)		(TA)		(WI)		
Calycoseris wrightii	OP	CP	TA		WI		
(***Carthamus tinctorius*)	(OP)				(WI)		
**Centaurea melitensis*	OP	CP		SU			

†*Chaenactis carphoclinia*	OP	CP	TA		WI		
†*Chaenactis stevioides*	OP	CP	TA		WI		
†*Cirsium neomexicanum*	OP				WI		
Diaperia verna	OP	CP			WI		
(*Dicoria canescens*)		(CP)			(WI)		
Dieteria asteroides	OP					NS/P	
Eclipta prostrata	OP					NS	
†*Encelia farinosa*	OP	CP	TA				PR
Encelia farinosa × *E. frutescens*	OP		TA				PR
Encelia frutescens	OP	CP	TA				PR
†*Ericameria cuneata*	OP	CP	(TA)				PR
†*Ericameria laricifolia*	OP		(TA)				PR
(††*Ericameria teretifolia*)	(OP)		(TA)				(PR)
(†*Ericameria* sp.)	(†OP)						(PR)
**Erigeron canadensis*	OP	CP		SU			
Erigeron lobatus	OP	CP	TA			NS	
Eriophyllum lanosum	OP	CP			WI		
Gaillardia arizonica	OP	CP			WI		
Gamochaeta stagnalis	OP				WI		
†*Geraea canescens*	OP	CP	TA		WI		
Gutierrezia arizonica	OP	CP			WI		
†*Gutierrezia sarothrae*	OP	CP					PR
†*Gymnosperma glutinosum*	OP	CP	TA				PR
(***Helianthus annuus*)	(OP)			(SU)			
Helianthus niveus		CP		SU			
(††*Heterotheca* sp.)			(TA)		(W/P)		
Hymenothrix wislizeni	OP	CP			W/P		
Hymenoxys odorata		CP			WI		
Isocoma acradenia	OP	CP					PR
Koanophyllon palmeri	OP						PR
**Lactuca serriola*	OP	CP	TA			NS	
Laënnecia coulteri	OP	CP	TA	SU			
Leucosyris arida	OP	CP				NS/P	
Leucosyris carnosa	OP						PR
Logfia arizonica	OP	CP	TA		WI		
Logfia depressa	OP	CP			WI		
Logfia filaginoides	OP	CP	TA		WI		
Machaeranthera tagetina	OP					NS	
Malacothrix fendleri	OP	CP			WI		
Malacothrix glabrata	OP	CP			WI		
Malacothrix sonorae	OP	CP			WI		
Monoptilon bellioides	OP	CP	TA		WI		
**Oncosiphon piluliferum*	OP	CP			WI		
Packera quercetorum	OP						PR
Palafoxia arida	OP	CP	TA		WI		
Parthenice mollis	OP			SU			
Pectis cylindrica		CP		SU			
Pectis linifolia	OP			SU			

Pectis papposa	OP	CP	TA	SU			
Perityle ajoensis	OP						PR
†*Perityle emoryi*	OP	CP	TA		WI		
(††*Perityle* sp.)	(OP)				(WI)		
†*Peucephyllum schottii*		CP	TA				PR
Pleurocoronis laphamioides	OP						PR
Pleurocoronis pluriseta		CP	TA				PR
(†*Pleurocoronis* sp.)			(TA)				(PR)
Pluchea odorata	OP			SU			
Pluchea sericea	OP						PR
†*Porophyllum gracile*	OP	CP	TA				PR
Prenanthella exigua	OP	CP	TA		WI		
Psathyrotes ramosissima		CP	TA		WI		
Pseudognaphalium canescens	OP						PR
Psilostrophe cooperi	OP	CP					PR
Rafinesquia californica	OP	CP			WI		
†*Rafinesquia neomexicana*	OP	CP	TA		WI		
Senecio flaccidus	OP				WI		
Senecio lemmonii	OP	CP			W/P		
Senecio mohavensis	OP	CP	TA		WI		
**Sonchus asper*	OP	CP	TA		WI		
**Sonchus oleraceus*	OP	CP	TA		WI		
Stephanomeria exigua	OP				WI		
Stephanomeria pauciflora	OP	CP	TA				PR
Stephanomeria schottii		CP			WI		
Stylocline gnaphaloides	OP				WI		
Stylocline micropoides	OP	CP	TA		WI		
†*Thymophylla concinna*	OP	CP			WI		
Thymophylla pentachaeta	OP	CP					PR
Townsendia annua	OP				WI		
Trichoptilium incisum	OP	CP	TA		WI		
†*Trixis californica*	OP	CP	TA				PR
Uropappus lindleyi	OP	CP			WI		
(***Verbesina encelioides*)	(OP)					(NS)	
Xanthisma gracile	OP			SU			
†*Xanthisma spinulosum*	OP	CP	TA				PR
Zinnia acerosa	OP						PR
Totals: 106	97	74	43	10	39	8	49

Approximately 57 taxa (59%) of the composite species in the flora area are annuals, mostly short-lived annuals or ephemerals. Desert annuals that complete their life cycle within a single season are termed ephemerals, and those with longer life spans are termed annuals, although the distinctions can be subjective. Three general kinds of ephemerals are distinguished: (1) Winter-spring ephemerals grow during the cooler seasons and may flower during late fall, winter, or spring. The majority of ephemerals (39 taxa) in the flora area are cool-season, or winter-spring ephemerals. (2) Hot weather or summer ephemerals usually germinate with the first substantial summer thunderstorms. Some may also grow with early fall rains (such as hurricane-fringe storms) while the soil and air temperatures are still high, allowing quick maturity. (3) Non-seasonal ephemerals grow with sufficient soil moisture at any time of the year. Most of the remaining local composites are

herbaceous perennials or small shrubs, and a few such as *Ambrosia monogyra*, *Baccharis salicifolia*, *B. sarothroides*, *Peucephyllum schottii*, and *Pluchea sericea* are woody shrubs reaching 1.5–3 m in height. Three small composite shrubs are important and widespread components of the local desert vegetation: *Ambrosia deltoidea, A. dumosa,* and *Encelia farinosa*.

Most composites in this flora are insect-pollinated. Approximately 52 species have yellow flowers, e.g., *Encelia farinosa, Baileya* spp., *Geraea canescens,* and *Pectis papposa.* Twenty-nine species have white to pinkish flowers, e.g., *Rafinesquia neomexicana*, and some are generally nocturnal or crepuscular, e.g., *Stephanomeria* spp. There are only a few species with blue, lavender, or pink flowers, e.g., *Cirsium neomexicanum*, *Pluchea odorata*, and *P. sericea*. Some have blue, purple, or pink rays but yellow disk flowers, e.g., *Erigeron lobatus*, *Dieteria asteroides*, *Leucosyris arida*, and *Machaeranthera tagetina*. The Ambrosiinae, e.g., *Ambrosia,* are wind-pollinated, with corollas absent from female flowers and reduced on male flowers. Others, such as the filaginoids (*Diaperia, Logfia,* and *Stylocline*), have minute flowers with reduced corollas and apparently are selfing (at least within a single flower head). Other apparently selfing comps in the flora area include *Pectis cylindrica* and *Uropappus lindleyi*.

The composite genera in the flora of southwestern Arizona are classified in the following higher taxa (adapted from Barkley et al. 2006):

SUBFAMILY ASTEROIDEAE

Tribe Anthemideae
- *Artemisia*
- *Oncosiphon*

Tribe Astereae
- *Acamptopappus*
- *Baccharis*
- *Dieteria*
- *Ericameria*
- *Erigeron*
- *Gutierrezia*
- *Gymnosperma*
- *Heterotheca*
- *Isocoma*
- *Laënnecia*
- *Leucosyris*
- *Machaeranthera*
- *Monoptilon*
- *Townsendia*
- *Xanthisma*

Tribe Eupatorieae
- *Ageratina*
- *Brickellia*
- *Koanophyllon*
- *Pleurocoronis*

Tribe Gnaphalieae
- *Diaperia*
- *Gamochaeta*
- *Logfia*
- *Pseudognaphalium*
- *Stylocline*

Tribe Heliantheae

Subtribe Ambrosiinae
- *Ambrosia*
- *Dicoria*
- *Parthenice*

Subtribe Baerinae
- *Eriophyllum*

Subtribe Chaenactidinae
- *Chaenactis*
- *Hymenothrix*
- *Palafoxia*
- *Peucephyllum*

Subtribe Ecliptinae
- *Eclipta*
- *Encelia*
- *Geraea*
- *Verbesina*
- *Zinnia*

Subtribe Gaillardinea
- *Baileya*
- *Gaillardia*
- *Hymenoxys*
- *Psathyrotes*
- *Psilostrophe*
- *Trichoptilium*

Subtribe Helianthinae
- *Bahiopsis*
- *Helianthus*

Subtribe Galinsoginae
Bebbia
Subtribe Pectidinae
Adenophyllum
Pectis
Porophyllum
Thymophylla
Subtribe Peritylinae
Perityle
Subtribe Plucheeae
Pluchea
Subtribe Senecioneae
Packera
Senecio
SUBFAMILY CARDUOIDEAE
Tribe Cynareae
Carthamus
Centaurea
Cirsium
SUBFAMILY CICHORIOIDEAE
Tribe Cichorieae
Calycoseris
Lactuca
Malacothrix
Prenanthella
Rafinesquia
Sonchus
Stephanomeria
Uropappus
SUBFAMILY MUTISIOIDEAE
Tribe Mutisieae
Acourtia
Trixis

Key to the Genera

♦**1. Plants with milky sap**; all florets bisexual and ligulate, the ligules 5-lobed, similar in shape (inner florets often smaller), and strap-like or ray-like.

2. Pappus of lanceolate, papery scales, cleft at apex with the midrib extending into a slender bristle, the bristle not plumose..... **Uropappus**
2. Pappus of slender feathery or thread-like (capillary) bristles (if expanded and scale-like at base, then the apex plumose).

3. Pappus bristles plumose.

4. Heads medium to large, the larger phyllaries (13) 17–22 mm long; ligules of larger (outer) florets usually 15–30 mm long; achenes tapering into a slender beak; pappus bristles (6) 9.5–14 mm long..... **Rafinesquia**
4. Heads small, the phyllaries 6–10.5 mm long; ligules 6–12 mm long; achenes columnar (not tapering), ending abruptly (truncate); pappus bristles 2.2–8 mm long..... **Stephanomeria**

3. Pappus bristles thread-like (capillary), smooth to barbellate but not plumose.

5. Achenes beaked, the beak slender like a wire and about as long as, or longer than, body of achene..... **Lactuca**
5. Achenes not beaked (sometimes narrowed to a neck but the neck not slender like a wire and much shorter than the achene body).

6. Achenes flattened, rounded at apex; stems leafy, at least below; leaf margins bristle-tipped or not..... **Sonchus**
6. Achenes cylindrical, truncate at apex; stem leaves absent, few, or much reduced; leaf margins not bristly.

7. Florets 3 or 4 per head, the phyllaries 4–5 mm long..... **Prenanthella**
7. Florets 10 or more, the phyllaries more than 7 mm long.

8. Plants without tack-shaped hairs, the involucres and new growth moderately woolly; achenes 1.8–2.4 mm long, cylindrical (without a neck)…….. **Malacothrix**
8. Upper part of plants including involucres with conspicuous tack-shaped glands, otherwise glabrous or nearly so; achenes 7 mm long, narrowed to a slender neck just below pappus…… **Calycoseris**

♦1. Sap not milky; florets not strictly ligulate; heads with (1) ray and disk florets, the rays sterile or pistillate, usually 3-toothed or 3-lobed, or (2) disk or disk-like florets only, the corollas showy to reduced or lacking (florets sometimes enclosed in burs), or (3) bilabiate (2-lipped) florets only.

⊙9. Vegetative parts (herbage and phyllaries) conspicuously resinous-glutinous, sticky and aromatic (these plants also key out elsewhere).

10. Monoecious, male and female flower heads on the same plant, the florets of each flower head of a single sex, the female flowers enclosed in burs or nut-like structures…….. **Ambrosia**
10. Dioecious, male and female flower heads on separate plants, or the flower heads with male and female or bisexual florets, flowers not in burs or nut-like structures.

11. Annuals (stems and leaves glandular-sticky, phyllaries mostly equal in length and glandular, flowers dull whitish, achenes 1 mm long;)}…….. **Laënnecia**
11. Herbaceous perennials or shrubs.

12. Leaves pinnately 2- or 3-times dissected nearly to the midrib…….. **Hymenothrix**
12. Leaves with entire margins or sometimes lobed but not pinnately dissected.

13. Leaves filiform, terete or nearly so, not lobed, less than 2 mm wide.

14. Woody shrubs usually 1 m or more tall; flowers heads 1+ cm long, solitary and sessile at stem tips…… **Peucephyllum**
14. Small shrubs or subshrubs mostly 1 m or less tall; flower heads 4–6 mm long.

15. Flower heads 5–6 mm long; heads with 12–22 flowers; achenes 3.5–4 mm long. ……..**Ericameria laricifolia**
15. Flower heads 4–5 mm long; heads with 8–12 flowers; achenes 1.8–2 mm long. …….. **Gutierrezia sarothrae**
13. Leaves not filiform or terete, 2 mm or more wide, or if very narrow then at least some leaves toothed or lobed and the blades flattened or at least not terete.

16. Heads with small ray florets as well as disk florets; pappus none…… **Gymnosperma**
16. Heads of disk florets; pappus conspicuous.

17. Plants often 1–2+ m tall; male and female flowers on separate plants; flowers dull whitish…….. **Baccharis**
17. Plants not more than 1 m tall; flowers bisexual and yellow…….. **Isocoma**

⊙9. Vegetative parts not conspicuously resinous-glutinous and sticky.

18. Heads of bilabiate florets only; achenes expanded at apex into a disk bearing numerous pappus bristles.

19. Perennial herbs; leaves usually 2 cm or more in width, often firm, spinescent-toothed, largely semi-persistent, often not losing their shape when dry; flowers lavender to pinkish. ..... **Acourtia**
19. Small shrubs; leaves usually less than 1.5 (2) cm wide, thin and soft, not spinescent-toothed, shriveling when dry; flowers yellow..... **Trixis**

18. Heads with ray and disk florets, or only disk or disk-like florets, the florets not bilabiate; achenes various.

■**20. Heads of disk and ray florets,** the rays usually obvious (taxa with small, inconspicuous, or early-deciduous rays will key out in either choice).

21. Perennials (dwarf shrubs) with conspicuous white rays..... **Zinnia**
21. Ephemerals or perennials, the rays not white, or if white then not perennials.

✪**22. Pappus none** (caution: refers to absence of pappus at top of achene; do not confuse hairs on side of achenes with the pappus).

23. Leaves opposite; ray white, minute, and numerous..... **Eclipta**
23. Leaves alternate (sometimes opposite below in *Helianthus*).

24. Leaves essentially glabrous (minutely scabrous), usually resinous; stems slender and woody; heads 1.5 mm wide..... **Gymnosperma**
24. Leaves hairy, not resinous; herbaceous or if slightly woody then stems not slender; heads more than 10 mm wide.

25. Larger leaves basal, near ground; rays persistent; achenes more or less cylindrical and ribbed..... **Baileya**
25. Leaves terminal or along stems; rays not persistent; achenes flattened or 4-angled and not ribbed.

26. Weak-wooded shrubs; leaves mostly crowded (close together) at stem tips; herbage, especially stem tips, white woolly; achenes flattened, the margins outlined with white hairs; pappus absent..... **Encelia farinosa**
26. Ephemerals or herbaceous perennials; leaves scattered along stems; achenes angular or only slightly compressed, the margins undifferentiated; pappus of 2 or more deciduous scales. ..... **Helianthus**

✪**22. Pappus present**, at least on disk achenes.

27. Rays with (2) 3 (4) terminal teeth or lobes.

28. Most leaves with slender lobes (less than 1 mm wide); flower heads (receptacle) globose to conical..... **Hymenoxys**
28. Leaves not lobed or lobes more than 1 mm wide; flower heads (receptacle) not globose or conical.

29. Plants stinky; leaves grayish, opposite below, alternate above, larger leaves with stipule-like leafy appendages near the petiole base; disk achenes enclosed in chaffy bracts; pappus none on ray achenes, of 1 or 2 short awns on disk achenes..... **Verbesina**

29. Plants not stinky; leaves green or grayish, alternate, without stipule-like appendages; achenes not enclosed in chaffy bracts; pappus of scales.

30. Leaves green, disk achenes not enclosed in chaffy bracts; rays not persistent ..... **Gaillardia**
30. Leaves grayish (plants densely white-hairy); rays persistent..... **Psilostrophe**

27. Rays entire, not cleft into lobes.

31. Rays white, pink, or lavender (not yellow); disk yellow.

32. Rays white or pink (mostly cool-season ephemerals).

33. Rays white.

34. Plants glabrous.

35. Plants (especially leaves and phyllaries) with dark-colored, oval or round oil glands..... **Thymophylla concinna**
35. Plants without oil glands.

36. Leaves 1–2 mm wide; achenes densely hairy throughout, and with bulbous-tipped hairs..... **Gutierrezia arizonica**
36. Plants essentially glabrous; leaves more than 10 mm wide; achenes with hairs at margins and not bulbous tipped..... **Perityle emoryi**

34. Plants pubescent.

37. Plants white-woolly; leaves linear to narrowly oblanceolate, entire. ..... **Eriophyllum**
37. Plants green, with scattered short hairs; leaf blades palmately toothed to lobed..... **Perityle emoryi**

33. Rays pink

38. Leaves 0.7–3.5 mm long; rays curling (rolling) in with age; achenes 1.5 mm long, with straight hairs; pappus of golden-brown scales and bristles, not barbed. ..... **Monoptilon**
38. Leaves 1–2 cm long; rays remaining straight (not rolling); achenes 2–3 mm long, with knob-tipped hairs; pappus bristles white and barbed..... **Townsendia**

32. Rays lavender or purple.

39. Plants dotted with conspicuous oil glands; leaves opposite; florets purplish and inconspicuous; rare in the flora area..... **Pectis linifolia**
39. Plants without oil glands; leaves basal or alternate; not rare.

40. Larger leaves petioled; rays more than 80..... **Erigeron lobatus**
40. Leaves petioled or sessile; rays fewer than 40.

41. Leaves petioled or sessile; rays 8–16; disk achenes covered with white hairs…… **Machaeranthera**
41. Leaves petioled or sessile; rays 20 or more.

42. Leaves sessile; rays more than 30; ray and disk achenes with a pappus of many bristles…… **Dieteria**
42. Leaves sessile or larger ones petioled; rays 20–35+; ray achenes without a pappus…… **Leucosyris arida**

31. Ray and disk florets/corollas yellow.

43. Plants dotted with conspicuous oil glands; glabrous or essentially so.

44. Leaves opposite; entire except marginal bristles near leaf base…… **Pectis**
44. Leaves opposite or alternate; pinnately lobed; without marginal bristles.

45. Leaves mostly alternate; leaf segments needle-like; phyllaries separate (at least with age); rays yellow-orange…… **Adenophyllum**
45. Leaves mostly opposite (upper ones may be alternate); leaf segments not sharp-pointed; inner phyllaries united most of their length; rays yellow.
…… **Thymophylla pentachaeta**

43. Plants without oil glands; mostly pubescent and often glandular-pubescent.

46. Heads medium-size to large, usually (2) 3–5 cm wide including rays; receptacles with chaffy bracts subtending and partly enclosing disk florets.

47. Phyllaries margins conspicuously ciliate with long white hairs; winter-spring ephemerals…… **Geraea**
47. Phyllaries not ciliate; non-seasonal ephemerals or shrubs.

48. Much-branched subshrubs or shrubs; heads including rays not more than 3.5 cm wide; phyllaries not leafy, 5 × 1.5–2 mm; rays 1.2–1.5 cm long.
…… **Bahiopsis**
48. Few-branched herbaceous perennials or rarely ephemerals; heads including rays (3.5) 4–9 cm wide; phyllaries leaf-like, 8–10 × 1.8–3.5 mm; rays mostly 2–3 cm long…… **Helianthus**

46. Heads small to medium-size, mostly less than 2.5 cm wide; receptacles without chaffy bracts (disk florets not subtended by bracts).

49. Pappus of many, slender and soft (capillary) white bristles.

50. Terminal leaf lobe much broader and larger than the lateral lobes; calyculus inconspicuous or absent…… **Packera**
50. Leaves simple or with slender lobes, the terminal lobe not larger than lateral lobes; phyllaries equal, and with an outer series of smaller, accessory bracts (the calyculus)…… **Senecio**

49. Pappus various, not of many, soft, slender, white bristles.

51. Plants densely white-hairy; rays persistent..... **Psilostrophe**
51. Plants not densely white-hairy; rays not persistent.

52. Herbage glutinous, glandular punctate with dot-like glands the same color as the herbage; flower heads 4–5 mm wide, in dense clusters. ..... **Gutierrezia sarothrae**
52. Herbage not glutinous and not glandular punctate; flowers heads 1.5–3.5 cm wide, solitary or few on a stem..... **Xanthisma**

■**20. Heads of disk florets only**, outer florets without an obvious ligule or ray, or if ray florets present then disk-like (inconspicuous or reduced, or lacking a well-developed ligule—eligulate; if in doubt about presence of rays then take this choice).

53. Heads unisexual; female florets enclosed in a bur or woody, winged involucre or nut-like structure..... **Ambrosia**
53. Heads not unisexual (or some heads of *Dicoria* with male flowers only); female florets not enclosed in burs or as above.

54. Ephemerals or perhaps biennials (*Cirsium*); plants thistles or somewhat thistle-like, the heads and leaves spinescent (rarely not spiny in some cultivars of *Carthamus*).

55. Stems shiny white, not winged; pappus none..... **Carthamus**
55. Stems green and not shiny, winged with decurrent leaf bases; pappus bristles well developed.

56. Plants commonly more than 1 m tall; lower leaves mostly 20–40 cm long; flower heads more than 3.5 cm wide, the flowers pale lavender..... **Cirsium**
56. Plants generally less than 0.6 m tall (to 1 m when shaded and well watered); lower leaves 5–15 cm long; heads 2.5–2.8 cm wide, the flowers bright yellow..... **Centaurea**

54. Ephemerals or perennials; heads and leaves not spinescent; plants not thistle-like.

❖**57. Plants tomentose, white-woolly**.

58. Herbaceous perennials; leaves bicolored (greener above), and especially the lower leaves with a few large lobes..... **Artemisia ludoviciana**
58. Ephemeral or herbaceous perennials; leaves similar (or nearly so) in color on both surfaces, entire or lobed.

59. Stems thick; leaves obviously petioled, the blades as wide as or wider than long, thick, and with conspicuously incised veins..... **Psathyrotes**
59. Stems not noticeably thick; leaves sessile or the petioles inconspicuous, short, or winged, the blades longer than wide, not noticeably thick, the veins inconspicuous.

60. Leaves coarsely toothed; individual flowers small but readily visible, bright yellow; achenes more than 2 mm long..... **Trichoptilium**
60. Leaves entire; individual flowers minute, inconspicuous and dull-colored; achenes 1 mm or less in length.

61. Herbaceous perennials also flowering in first season, mostly more than (15) 20 cm tall. ..... **Pseudognaphalium**

61. Small cool-season ephemerals, usually less than 15 (20) cm tall ("fuzzy little comps").

62. Pappus none…… **Diaperia**
62. Pappus present.

63. Majority of bracts on flower head not directly associated with florets; all florets with a pappus; wet soil at waterholes…….. **Gamochaeta**
63. Majority of bracts on head partially or completely enclosing a floret; outer florets without a pappus; widespread, desert habitats and dry watercourses.

64. Inner florets all bisexual, the achenes usually developing and with copious pappus (averaging more than 12 bristles per floret); receptacle often flat-topped ……..…… **Logfia**
64. Inner florets all staminate, the achenes not developing and their pappus none or vestigial; receptacle often conical or cylindrical…….... **Stylocline**

❖**57. Plants glabrous or hairy but not woolly**.

65. Tall annuals or weakly-wooded shrubs; outer or all florets subtended by chaffy bracts of the receptacle, the bracts folded around the achenes and falling with them.

66. Annuals; pappus none.

67. Plants not notably tall, less than 1 m tall; leaves 3–6 cm long, opposite below, alternate above..... **Dicoria**
67. Tall annuals, mostly more than 1 m tall; leaves more than 10 cm long, all alternate. …… **Parthenice**

66. Perennial subshrubs; pappus present.

68. Leaves alternate; achenes 7–10 mm long, the margins with long white hairs; pappus none. …… **Encelia frutescens**
68. Leaves opposite, or the upper ones alternate; achenes 2–4 mm long, the margins ciliate or not but not with long white hairs; pappus present.

69. Achenes 2.8–4 mm long, the margins ciliate; pappus of lacerate and aristate scales, not plumose…….. **Bahiopsis**
69. Achenes 2.3–3 mm long; pappus of plumose (feathery) bristles…….. **Bebbia**

65. Annuals, herbaceous perennials, or shrubs; receptacle naked, without chaffy bracts.

70. Plants glaucous, the herbage bluish green.

71. Plants rhizomatous; not aromatic, lacking oil glands; flowers bright yellow. …….. **Leucosyris carnosa**
71. Plants not rhizomatous; pungently aromatic, the leaves and bracts with conspicuous, elongated oil glands; flowers whitish to pinkish…….. **Porophyllum**

70. Plants not glaucous, the herbage not bluish green.

★**72. Ephemerals or annuals** (borderline cases key out in both couplets)

73. Spring ephemerals; leaves 1–3-times pinnatisect (pinnately divided to midrib).

74. Flower heads 10–17 mm long and longer than wide; phyllaries 5–10 mm long; flowers white to pale pinkish; pappus of papery scales…… **Chaenactis**
74. Flower heads 5–8 mm long, globose; phyllaries 3 mm long; flowers bright yellow; pappus of a minute crown…… **Oncosiphon**

73. Ephemerals or perennials; leaves entire or margins lobed or parted halfway or less to midrib.

75. Leaf surfaces mostly grayish or grayish green with coarse, grayish or white hairs; achenes at least 4 mm long…… **Palafoxia**
75. Leaf surfaces usually green; glabrous or the hairs not as in *Palafoxia*; achenes 3.2 mm or less in length.

76. Leaves opposite (plants flowering in first year)…… **Ageratina**
76. Leaves alternate.

77. Delicate spring ephemerals; leaves very thin, the lower surfaces usually purple; flowers yellow; phyllaries 6–7.5 mm long; achenes 2.8–3.2 mm long; pappus of numerous soft bristles…… **Senecio mohavensis**
77. Ephemerals/annuals, summer or non-seasonal, mostly robust and not delicate; leaves not noticeably thin and not purplish; flowers white, lavender or greenish; phyllaries 2.5–5.5 mm long; achenes 0.8–1.3 mm long.

78. Ephemerals; phyllaries 2.5–3.5 mm long; flowers whitish; weeds mostly in disturbed habitats…… **Erigeron canadensis**
78. Annuals (sometimes surviving more than one year); longer phyllaries 4–5.5 mm; phyllaries and flowers rose-lavender; mostly natural, wetland habitats (Quitobaquito). …… **Pluchea odorata**

★**72. Shrubs or subshrubs** (or dwarf shrubs or subshrubs), the vegetative parts usually present all year.

79. Achenes without a pappus…… **Artemisia dracunculus**
79. Achenes with pappus.

80. Leaves petioled, junction of blade and petiole abrupt and well marked, the petiole usually more than ⅓ as long as blade (at least among the lower leaves); or if the petiole shorter, then the blade spinose-toothed (*Brickellia atractyloides*) or broadly spatulate (*Ericameria cuneata*).

81. Leaf blades broadly spatulate…… **Ericameria cuneata**
81. Leaf blades not broadly spatulate.

82. Pappus bristles of two kinds: broadly membranous-margined bristles and slender, barbellate bristles…… **Pleurocoronis**
82. Pappus bristles uniform, slender (capillary), and not barbellate, the margins not differentiated, or pappus none.

83. Flower heads 4–6 mm long; achenes 1–2 mm long.

84. Heads pedicelled, with 10–30 florets; achenes 1.1–1.3 mm long…….. **Ageratina**
84. Individual heads sessile or subsessile or sometimes short-pedicelled (mostly with several heads crowded in small clusters), with 3–6 florets; achenes (1.5) 2 mm long. ……..…... **Koanophyllon**

83. Flower heads 8–15+ mm long; achenes 3–4 mm long.

85. Flower heads 10–15+ mm long; phyllaries striated; flowers pale yellowish or purplish; achenes prismatic, covered with short brownish hairs, the pappus of many white (capillary) bristles……..... **Brickellia**
85. Flower heads 8–10 mm long; phyllaries not striated; flowers yellow-orange; achenes flattened, the body blackish at maturity with thickened yellowish-white margins, the pappus none or with 1 or 2 slender awns…….. **Perityle ajoensis**

80. Leaves sessile or the blade gradually narrowed to an indistinct petiole less than 1/6 length of leaf, the blade entire to toothed but not spinose.

86. Leaves widest towards the tip (oblanceolate)…….... **Acamptopappus**
86. Leaves linear to narrowly elliptic or lanceolate, widest near the middle.

87. Flower heads 10–15 mm long.

88. Leaves conspicuously resinous and densely crowded at stems tips like a miniature fir-tree (internodes scarcely discernable); heads sessile, mostly solitary at stem tips; phyllaries not conspicuously graduated (similar in size in an inner series, plus an outer series of few, narrower and sometimes shorter phyllaries); flowers bright yellow…….. **Peucephyllum**
88. Leaves not resinous (or not conspicuously so), not crowded, the internodes apparent; flower heads stalked; phyllaries conspicuously graduated (imbricated); flowers whitish to lavender or pale yellow.

89. Herbage minutely pubescent but not glandular; leaves essentially sessile; achenes 3.5 mm long…… **Brickellia frutescens**
89. Herbage densely pubescent with stalked glandular hairs; leaves with a long, slender petiole and an arrow-shaped blade sometimes greatly reduced and indistinct; achenes 2.5–3 mm long…… **Pleurocoronis pluriseta**

87. Flower heads 4–8 mm long.

90. Flower heads 6–8 mm long; phyllary margins fringed; flowers yellow; achenes 2.3–4 mm long.

91. Phyllaries with a prominent resin pocket; achenes 2.3–2.5 mm long. …….. **Acamptopappus**
91. Phyllaries lacking a resin pocket; achenes 3–4 mm long……... **Koanophyllon**

90. Flower heads 4–7 mm long; flowers whitish to pinkish; phyllary margins not thin and fringed; achenes 1–1.7 mm long.

92. Herbage yellow-green to dull green, essentially glabrous or with short, inconspicuous hairs; flower heads unisexual (male and female flowers on separate plants); flowers whitish..... **Baccharis**
92. Herbage densely silvery hairy; heads with both male and female florets; flowers pinkish..... **Pluchea sericea**

Figure 2. (A) *Acourtia nana*, Highway Tank, between Ajo and Why, 13 May 2015. (B) *Acourtia wrightii*, Ajo Scenic Loop, Little Ajo Mts, 17 May 2015. (C) *Ambrosia ambrosioides*, Estes Canyon, 17 May 2015. (D) *Ambrosia confertiflora*, near N end of Ajo Mountain Drive, 17 May 2015. (E) *Ambrosia cordifolia*, Estes Canyon, 17 May 2015. (F) *Ambrosia deltoidea*, Ajo, 12 May 2015. (G) *Ambrosia dumosa*, Ajo, 12 May 2015. (H) *Bahiopsis parishii*, foothills of Diablo Mts, Ajo Mountain Drive, 17 May 2015. (I) *Baileya multiradiata*, Ajo Cemetery, 13 May 2015.

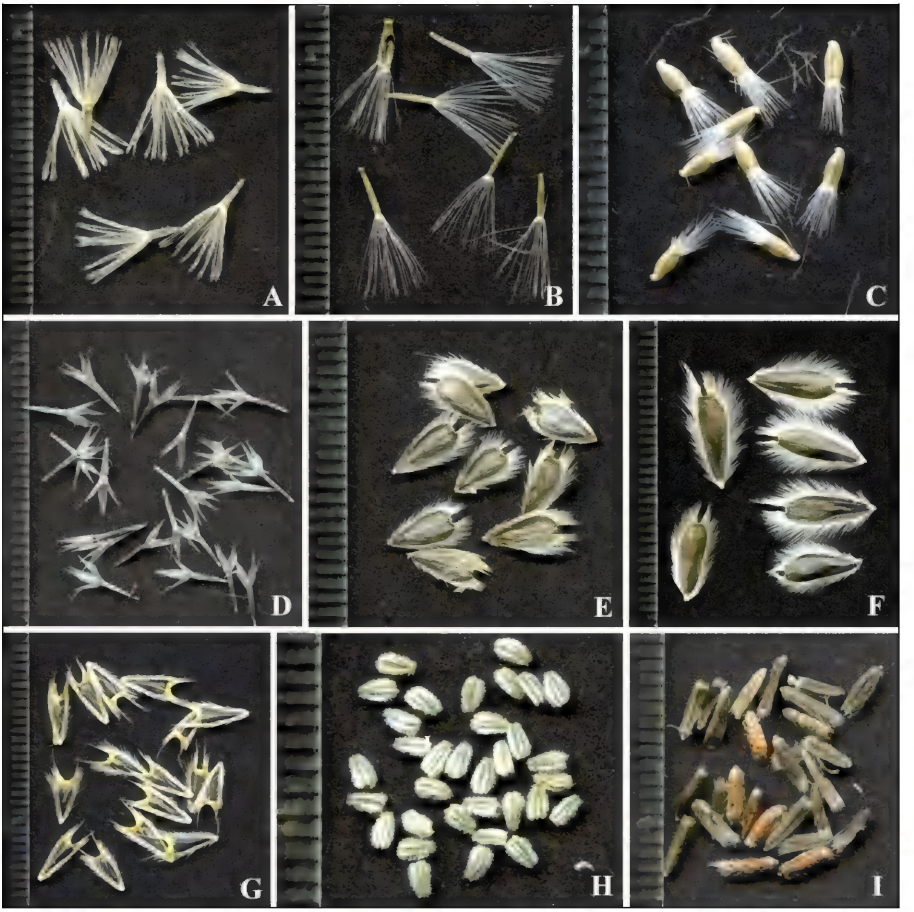

Figure 3. (A) *Bebbia juncea* Estes Canyon, 17 May 2015. (B) *Brickellia coulteri*, Diablo Mts on Ajo Mountain Drive, 17 May 2015. (C) *Centaurea melitensis*, Ajo Way and Sandario Road, 16 Apr 2015. (D) *Chaenactis stevioides*, Ajo, 13 May 2015. (E) *Encelia farinosa*, Ajo, 12 May 2015. (F) *Encelia frutescens*, Ajo, 12 May. (G) *Geraea canescens*, El Huerfano, Sonora, 18 May 2015. (H) *Gutierrezia arizonica*, valley E of Childs Mt, 12 May 2015. (I) *Helianthus niveus*, dunes 25 mi S of Sonoyta on Mex Hwy 8, 18 May 2015.

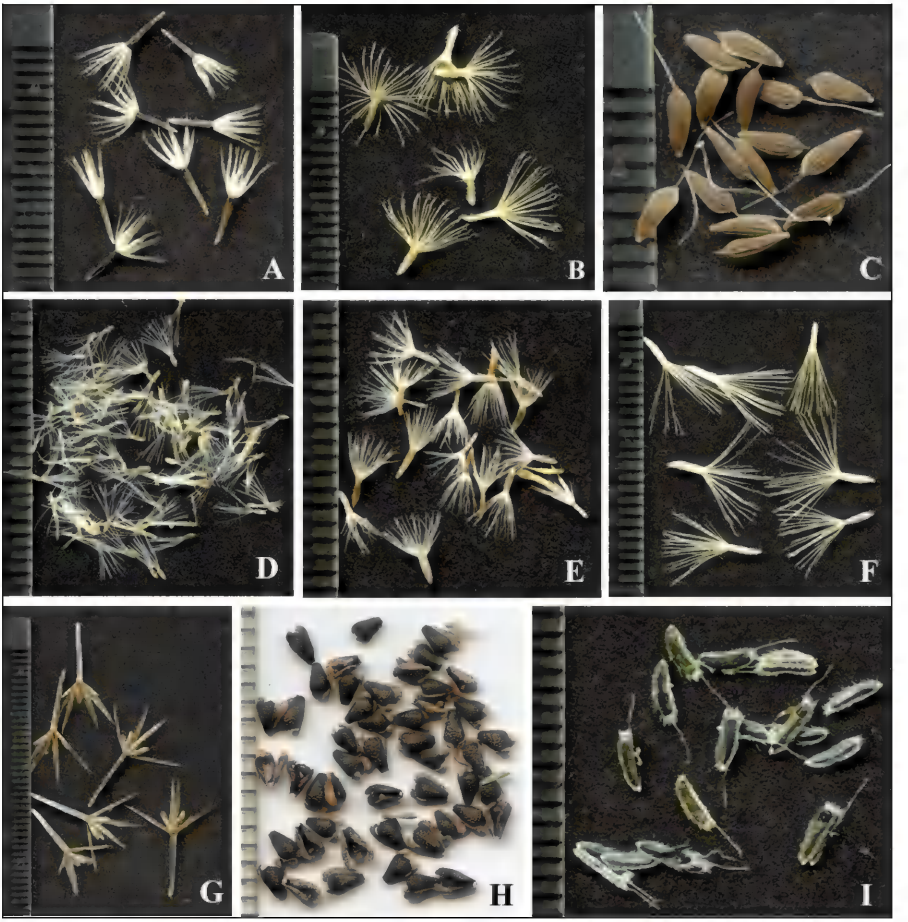

Figure 4. (A) *Hymenothrix wislizeni*, wash crossing Hwy 85, E of Why at mile 68, 18 May 2015. (B) *Isocoma acradenia*, Quitobaquito, 28 May 2015. (C) *Lactuca serriola*, Ajo, 12 May 2015. (D) *Laënnecia coulteri*, valley E of Childs Mt, 12 May 2015. (E) *Leucosyris arida*, floodplain of Rio Sonoyta near El Huerfano, Sonora, 18 May 2015. (F) *Leucosyris carnosa*, Quitobaquito, 28 May 2015. (G) *Palafoxia arida*, dunes 25 mi S of Sonoyta on Mex Hwy 8, 18 May 2015. (H) *Parthenice mollis*, Estes Wash, 30 Sep 2014. (I) *Perityle emoryi*, Aguajita, 18 May 2015.

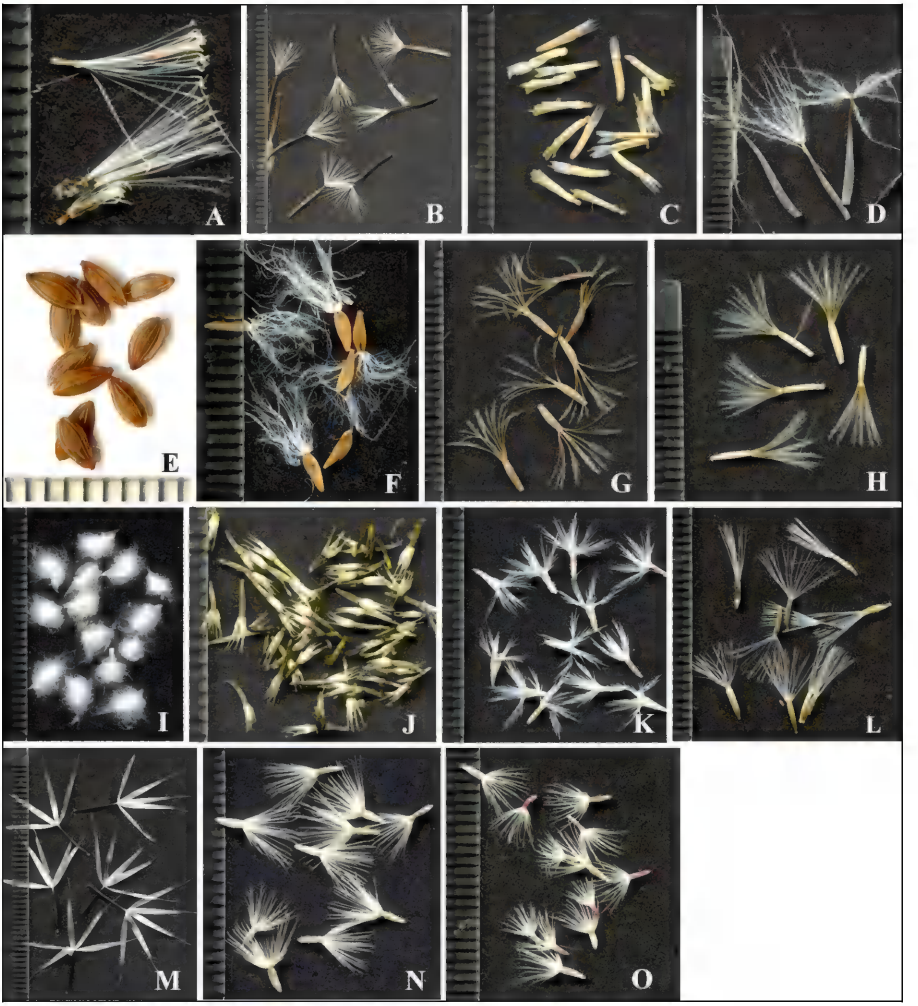

Figure 5. (A) *Pluchea sericea*, Aguajita Wash near international boundary, 18 May 2015. (B) *Porophyllum gracile*, foothills of Diablo Mts, N end of Ajo Mountain Drive, 30 Sep 2014. (C) *Psilostrophe cooperi*, Ajo, 12 May 2015. (D) *Rafinesquia neomexicana*, roadside ditch on Hwy 86 mile 62, 5 Apr 2015. (E) *Sonchus asper*, Alamo, 4 Apr 2015. (F) *Sonchus oleraceus*, Ajo Community Garden, 23 Mar 2015. (G) *Stephanomeria exigua*, Hwy 86, mile 125, 16 Apr 2015. (H) *Stephanomeria pauciflora*, Ajo, 13 May 2015. (I) *Stylocline micropoides*, Hwy 86, mile 62, 5 Apr 2015. (J) *Thymophylla pentachaeta*, Ajo, 13 May 2015. (K) *Trichoptilium incisum*, granite foothills of western Puerto Blanco Mts, 5 Mar 2015. (L) *Trixis californica*, Ajo Scenic Loop, Little Ajo Mts, 13 May 2015. (M) *Uropappus lindleyi*, 4 Apr 2015. (N) *Xanthisma spinulosum*, Ajo, 12 May 2015. (O) *Xanthisma gracile*, Kitt Peak Road, 23 May 2015.

Acamptopappus

Mojave and Sonoran deserts; 2 species. Astereae.

Acamptopappus sphaerocephalus (Harvey & A. Gray) A. Gray var. **sphaerocephalus**
Rayless goldenhead. Figure 6.

Small shrubs, moderately glutinous and glabrous except the leaf margins. Leaves alternate, 0.5–2 cm long, narrowly lanceolate or narrowly obovate or spatulate, the margins entire or ciliate with short, thick white hairs. Flower heads rounded, 6–8 mm wide, of yellow disk florets; phyllaries as broad as long, with a prominent resin pocket, the margins broadly membranous and fringed. Achenes 2.3–2.5 mm long, obconic, and densely covered with white hairs; pappus of white, moderately flattened and persistent bristles. Flowering at least in April and early May.

Gravelly flats and slopes; apparently rare in the Ajo Mountains, where it has been documented three times but not since 1942. Is it still present in the flora area?

Variety *sphaerocephalus* occurs in Arizona, mostly east and north of the flora area, and is documented in mountains in Yuma County. Also California, Nevada, and Utah. Another taxon, var. *hirtellus* S.F. Blake, in California and Nevada and perhaps Arizona, is distinguished by pubescence.

OP: Ajo Mts, *Taylor & Vorhies 18 Apr 1924*. Walls Well, *Nichol 28 Apr 1939*. Alamo Canyon, 2000 ft, *Tinkham 18 Apr 1942*.

Figure 6. *Acamptopappus sphaerocephalus* var. *sphaerocephalus*. Big Water, Kane Co., Utah, 18 May 2014, photos by Max Licher.

Acourtia

Herbaceous perennials. Leaves spinescent-toothed. Phyllaries firm, in 2–4 rows. Florets bilabiate (2-lipped and ray-like), all alike, and bisexual. Achenes elongated (linear-cylindrical to fusiform), often glandular, apex often expanded into a disk bearing a pappus of numerous barbellate bristles.

Southwestern U.S. to Central America; 41 species. A genus segregated from *Perezia*. Molecular evidence indicates *Acourtia* is most closely related to *Trixis* and not to *Perezia* (Kim et al. 2002), a genus now restricted to South America. Mutisieae.

1. Plants usually less than 20 cm tall; leaves rounded, about as wide as long; flower heads solitary at branch tips…… **Acourtia nana**
1. Plants usually more than 40 cm tall; leaves ovate, longer than wide; flower heads numerous, in panicles…….. **Acourtia wrightii**

Acourtia nana (A. Gray) Reveal & R.M. King
[*Perezia nana* A. Gray]
Desert holly. Figure 7.

Small herbaceous perennials from knotty, rhizomatous rootstocks, and often with tufts of brownish hairs at the lowermost and usually buried nodes. Stems mostly to 20 cm or less. Leaves mostly 2–6 per stem and held upright, sessile, more or less orbicular, firm and holly-like, 1–5 cm long, with coarse spinescent teeth, and semi-persistent even when dry. Flower heads solitary at stem tips, pinkish and attractively scented. Phyllaries in 4 rows (appearing graduated), green and often reddish tipped, the larger phyllaries to 12 mm long. Achenes 5–7 mm long, slender and cylindrical; pappus of many capillary white bristles 11–17 mm long. Flowering April to May with sufficient rains.

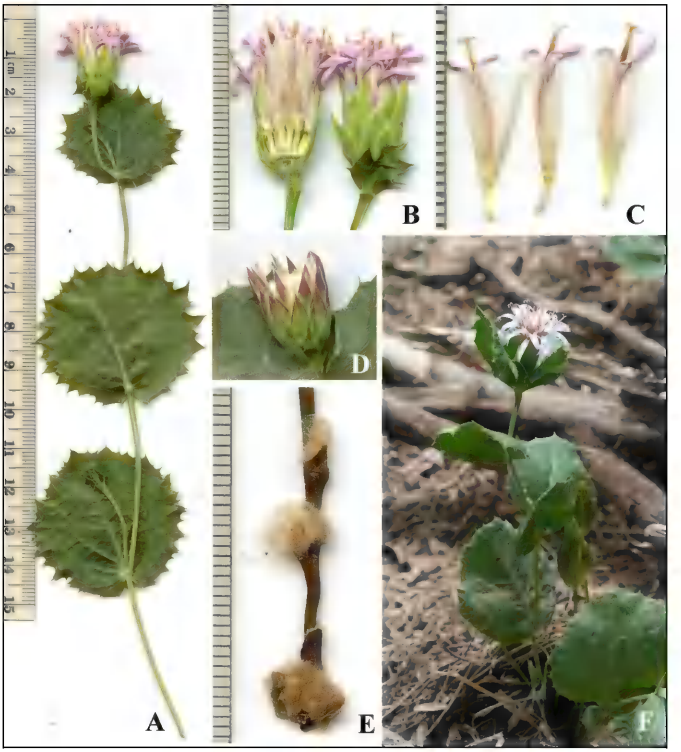

Figure 7. *Acourtia nana*. Highway Tank, S of Hwy 85 between Why and Ajo: (A–C) 8 Aug 2014; (E) 31 Jul 2014. Beneath *Prosopis velutina*, ditch to S of Hwy 86, mile 62, east of Why: (D) 1 Aug 2014; (F) 16 Aug 2006.

Localized in widely scattered places in Organ Pipe, often beneath shrubs and desert trees such as mesquites and *Condalia* in valley bottoms, lower bajadas, and washes. Common in the Valley of the Ajo near Cherioni Wash where it can be found under nearly every tree.

Arizona to Texas and northern Mexico; deserts and especially in mesquite grassland.

OP: Headquarters, *Supernaugh 1 May 1948* (ORPI). Cuerda de Leña Wash at N boundary, 13 Sep 1978, *Bowers 1537* (ORPI). Estes Canyon (Bowers 1980). Valley of the Ajo, sandy loam flat, 7 Oct 2006, *Rutman 2006-1007-1*.

Acourtia wrightii (A. Gray) Reveal & R.M. King
[*Perezia wrightii* A. Gray]
Brown-foot. Figure 8.

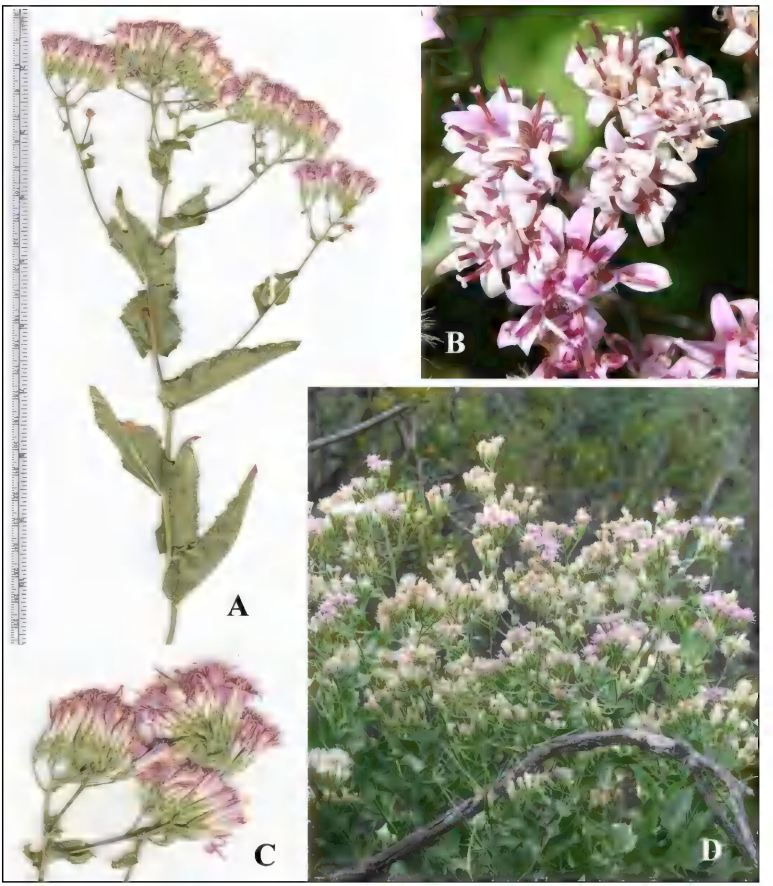

Figure 8. *Acourtia wrightii*. (A & C) Alamo Canyon, 21 May 2010. (B) Estes Canyon, 18 Mar 2005. (D) Riparian area south of the mine pit, Little Ajo Mts, 29 Sep 2007.

Herbaceous perennials with leafy stems sometimes to 1 m tall from hard, knotty bases with brown wool. Leaves mostly 8–12.5 × 3–5.5 cm, glandular-sticky, sessile, ovate to lanceolate, coarsely and irregularly toothed, the bases clasping the stem. Inflorescences branched with many-headed clusters of lavender-pink flowers. Phyllaries in 2 or 3 rows, thin, green to pink-tinged, the margins often membranous-ciliate, the larger phyllaries 6.5–7.5 mm long. Achenes 5.5–6.5 mm long, densely glandular; pappus of many white capillary bristles 7.5–9.5 mm long. Flowering mostly March and April and September–November.

Along small to large washes and canyons, and on rocky slopes. Eastern portion of Cabeza Prieta and scattered across Organ Pipe (except the southwestern margin) but most common in the eastern portion of the Monument and especially in larger mountains.

Central Mexico to southwestern United States but not in California.

OP: Alamo Canyon, *Nichol 4 May 1939*. N border of Monument, 11 Sep 1943, *Clark 10983* (ORPI, UNM). Bull Pasture Trail, 9 May 1979, *Bowers 1702*. Puerto Blanco Drive near milepost 3, *Beale 28 Mar 1988* (ORPI). Growler Wash, *Wirt 13 Oct 1988* (ORPI).

CP: Heart Tank, *Monson 10 Sep 1959* (CAB). 2 mi W of Little Tule Well on Charlie Bell Road, 18 Aug 1992, *Felger 92-652*. Charlie Bell Road 0.4 mi W of E Refuge boundary, 9 Apr 1993, *Felger 93-306*.

Adenophyllum

Southwestern United States to Central America; 10 species. A genus segregated from *Dyssodia*. Astereae, Pectidinae.

Adenophyllum porophylloides (A. Gray) Strother
[*Dyssodia porophylloides* A. Gray]
Dogweed. Figure 9.

Herbaceous or suffrutescent perennials, pungently aromatic with conspicuous maroon oil glands. Branches opposite below, usually alternate above, the foliage sparse. Leaves mostly alternate, the lower ones reaching 3+ cm long, pinnately 3–5 lobed, the lobes slender and with coarsely toothed margins; upper leaves often entire. Flower heads mostly 2 cm long. Phyllaries distinct to their bases, equal in length, plus a ring of reduced basal accessary bracts; phyllaries with conspicuous maroon oil glands. Disk florets yellow with reddish purple tips, the rays yellow-orange; flowering March and April, and sometimes October to December. Achenes 5 mm long, obconic, blackish; pappus of whitish to tan bristle-bearing scales.

Small arroyos, desert pavements, and rocky slopes in hills and mountains; widely scattered in Organ Pipe and occasional in canyons and arroyos in mountains in Cabeza Prieta. Sometimes forming large, localized populations.

Deserts in Arizona, California, Nevada, both Baja California states, Chihuahua, and Sonora.

OP: Senita Basin, 23 Mar 1969, *Lehto 15408* (ASU). Alamo Canyon: 2260 ft, 3 Dec 1977, *Bowers 967*; 2748 ft, 15 Mar 2003, *Rutman 2003-324* (ORPI). N of Visitor Center, 16 Apr 1985, *Van Devender 85-109*. 2.4 mi W of Hwy 85 on Puerto Blanco Road, 6 Apr 1988, *Felger 88-264*. Quitobaquito, 14 Sep 1988, *Felger 88-447*. Puerto Blanco Mts, Red Tanks Wash, 21 Sep 2013, *Rutman 20130921-5*.

CP: Agua Dulce Pass, 14 Sep 1992, *Felger 92-735*. Observations: Sheep Mt, N side, mid-elevations to peak, 31 Jan 1992, *Felger*; Cabeza Prieta Tanks, 15 Jun 1992, *Felger*. About ½ mi W of Chico Sunie Well, in drainage, 2 Feb 2003, *Rutman 2003-7*. Valley E of Growler Mts, Pozo Salado, 27 Feb 2007, *Fishbein 5497*.

Figure 9. *Adenophyllum porophylloides*. Ajo Scenic Loop, Little Ajo Mts: (A & D) 2 Oct 2013; (C & E) 23 May 2010. (B & F) Senita Basin, 10 May 2010.

Ageratina

North America to South America; 250 species. A genus segregated from *Eupatorium*. Eupatorieae.

Ageratina paupercula (A. Gray) R.M. King & H. Robinson
[*Eupatorium pauperculum* A. Gray]
Santa Rita snakeroot. Figure 10.

Herbaceous perennials to 40 cm tall from hard, knotty bases, sometimes reproductive in the first year or season. Leaves opposite, 4–9 cm long, petiolate, the blades thin, lanceolate, and with toothed margins. Flowers heads small (ca. 5–6 mm long), rather inconspicuous, numerous in dense clusters, and with disk florets only; flowers dull white; spring months with sufficient soil moisture,

especially March and April. Achenes 6–7 mm long, 5-ribbed, black, and glabrous; pappus of minutely barbed bristles.

Known from the Ajo Mountains by a single record. Members of this genus do not extend closer to the Sonoran Desert. The nearest population is in the Baboquivari Mountains.

Western Mexico northward in the Sierra Madre Occidental to mountains in southern and east-central Arizona. In addition to the key features, the leaves are more herbaceous or "softer" than those of *Koanophyllon palmeri*, with which it might be confused.

OP: Main canyon N of Alamo Canyon, under oaks, 3800 ft, 31 Mar 1948, *Darrow & Gould 4686*.

Figure 10. *Ageratina paupercula*. (A) Hartwell Canyon, NW of Sedona, Coconino Co., 21 May 2007, photo by Max Licher (SEINet). (B) Esperero Canyon, Santa Catalina Mts, 27 Mar 2010, photo by Ries Lindley (SEINet).

Ambrosia – Bursage, ragweed
[*Franseria*, *Hymenoclea*]

Perennial herbs or shrubs; with sessile or stalked glands. Leaves mostly alternate. Inflorescences spicate to racemose, the heads unisexual with inconspicuous disk florets, wind-pollinated, pappus none, the staminate heads above pistillate heads (or intermixed in *A. dumosa*, *A. monogyra*, and *A. salsola*). Staminate heads with cup- or plate-shaped involucres; the flowers producing large quantities of hay fever–causing pollen; stamens with connate filaments, the anthers separate or weakly joined, corollas inconspicuous. Pistillate heads with 1 to several florets and beaks, each beak representing a floret, the fruiting involucral bracts (phyllaries) hard and developing into a spinescent or bracteate bur or nut-like structure (measurements for burs include the spines), each spine or bract (wing) representing the distal portion of a phyllary; corollas absent. Seeds germinate within the bur.

Mostly in North America, some in Central and South America, some adventive in the Old World; 40 species. Heliantheae, Ambrosiinae.

1. Leaves and leaf segments filiform (thread-like), less than 2 mm wide; burs with flat wings narrowed basally.

2. Shrubs generally taller than wide, the stems erect; wings of fruiting bracts longer than wide; flowering in fall..... **Ambrosia monogyra**
2. Shrubs about as tall as wide, globose, the stems often spreading; wings of fruiting bracts about as wide as long; flowering in spring..... **Ambrosia salsola**

1. Leaves and leaf segments not filiform, more than 4 mm wide; burs with straight or hooked spines widest at base.

3. Leaves pinnately to tri-pinnately deeply dissected.

4. Herbaceous perennials, the stems dying back to the ground.
..... **Ambrosia confertiflora**
4. Small shrubs, the stems perennial and woody at least at the base..... **Ambrosia dumosa**

3. Leaf margins variously lobed, ragged, toothed, or rarely nearly entire, but not deeply dissected.

5. Leaves sessile and firm, with spine-tipped teeth..... **Ambrosia ilicifolia**
5. Leaves petioled, the blades "soft" and flexible (except some drought-stressed leaves), marginal teeth, if present, not spine-tipped.

6. Leaf blades broadly ovate and cordate at base, about as wide as long... **Ambrosia cordifolia**
6. Leaf blades lanceolate to narrowly triangular-lanceolate, longer than wide.

7. Long-stemmed shrubs, usually to 1+ m tall; leaf blades mostly 10 or more cm long; burs with hooked spines..... **Ambrosia ambrosioides**
7. Shrubs usually less than 0.8 m tall; leaf blades less than 6 cm long; spines of burs straight (rarely with a few hooked spines near the tip)..... **Ambrosia deltoidea**

Ambrosia ambrosioides (Cavanilles) W.W. Payne
[*Franseria ambrosioides* Cavanilles]
Canyon ragweed; *chicura*; ñuñuvĭ jej. Figure 11.

Shrubs with slender stems often to 1+ m tall. Herbage viscid resinous-glandular (especially when young), and with coarse, mostly spreading, white hairs. Leaves mostly alternate. Petioles 2–4 cm long; leaf blades triangular-lanceolate, often 10–25 cm long, glandular, often studded with small insect galls, the leaf margins ragged-toothed. Tardily drought deciduous, the dry, dead leaves persisting for 1 or 2 seasons; leaves and young stems sometimes frost killed, but the plants quickly recover. Burs resembling a cocklebur (*Xanthium*), 15 mm long, ellipsoid, with hooked spines and sessile and stalked greenish-golden, glistening glands (visible with 10× magnification). Growing with warm weather. Flowering March–May; fruiting in the same season.

Widespread across the flora area; common on floodplains and scour zones of drainages beneath or near desert trees such as ironwood, mesquite, and palo verde. Plants often top-killed by scouring floods, but rapidly recovering.

Northwestern Mexico and southern half of Arizona, and uncommon and probably not native in southern California (see Felger 2000) where it is actively spreading in some places.

The O'odham at Quitobaquito used this plant as a remedy for arthritis: "Make a bed of coals on cleared earth, scrape off coals, put down a layer of this ragweed, then lay the patient over the heated ragweed, and cover the patient with a blanket; it is like a dryland sweat lodge" (Philip Salcido & Delores Lewis in Felger et al. 1992: 17). Local Mexican people chew the leaves to relieve sinus congestion caused by allergic reactions, and this practice has passed into the Anglo community.

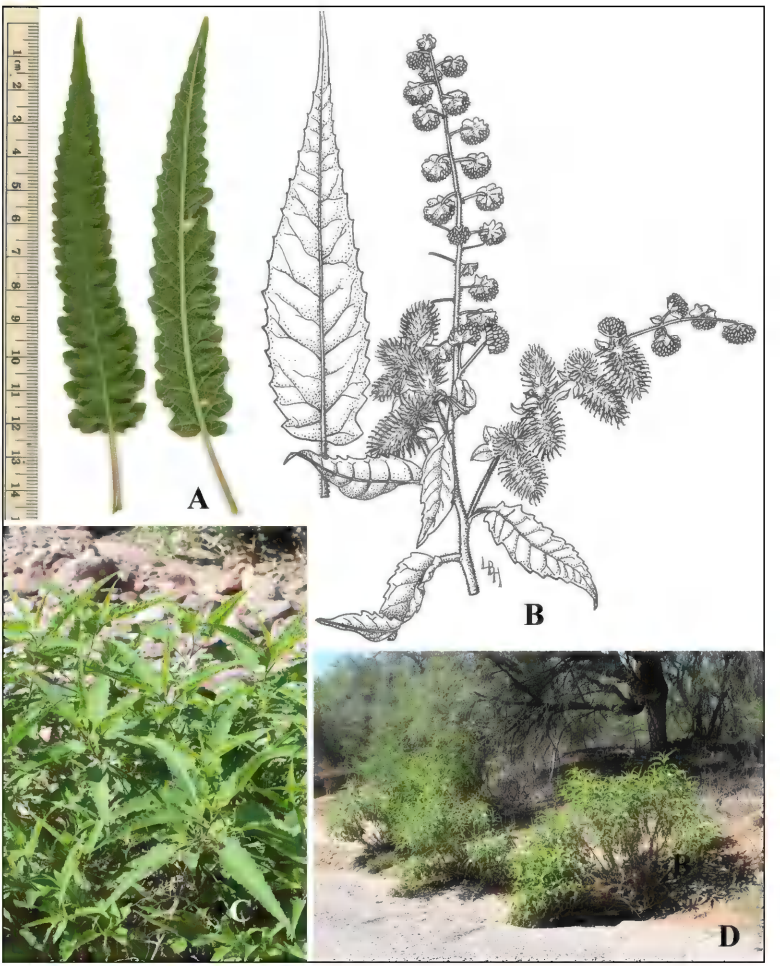

Figure 11. *Ambrosia ambrosioides*. Alamo Canyon: (A) 3 Sep 2014; (C) 9 Sep 2013. (B) By Lucretia Breazeale Hamilton. (D) Kuakatch Wash near Hwy 85, 13 Sep 2008.

OP: Quitobaquito, 27 Jan 1894, *Mearns* 2736 (US). Alamo Canyon, *Nichol 26 Mar 1939*. Bates Well, 17 Nov 1939, *Harbison 26163* (SD). Senita Basin, *Warren 10 Apr 1975*.

CP: Tule Tank, *Vorhies 11 Apr 1924*. Cabeza Prieta Tanks junction, *Duncan 28 Mar 1970* (CAB). Observations: Buckhorn Tank, Cabeza Prieta Tanks, 14 & 15 Jun 1992, *Felger*. Daniels Wash at Charlie Bell Road, *Balaban 05/03/1996* (CAB).

TA: Tinajas Altas, *Van Devender 9–10 Mar 1980*. Coyote Wash at Camino del Diablo, 10 Jan 2002, *Felger*, observation. 2.5 mi SE of Tinajas Altas, 22 Nov 2008, *Felger 08-203*.

Ambrosia confertiflora de Candolle
Slim-leaf bursage; *estafiate*; mo'ostalk. Figure 12.

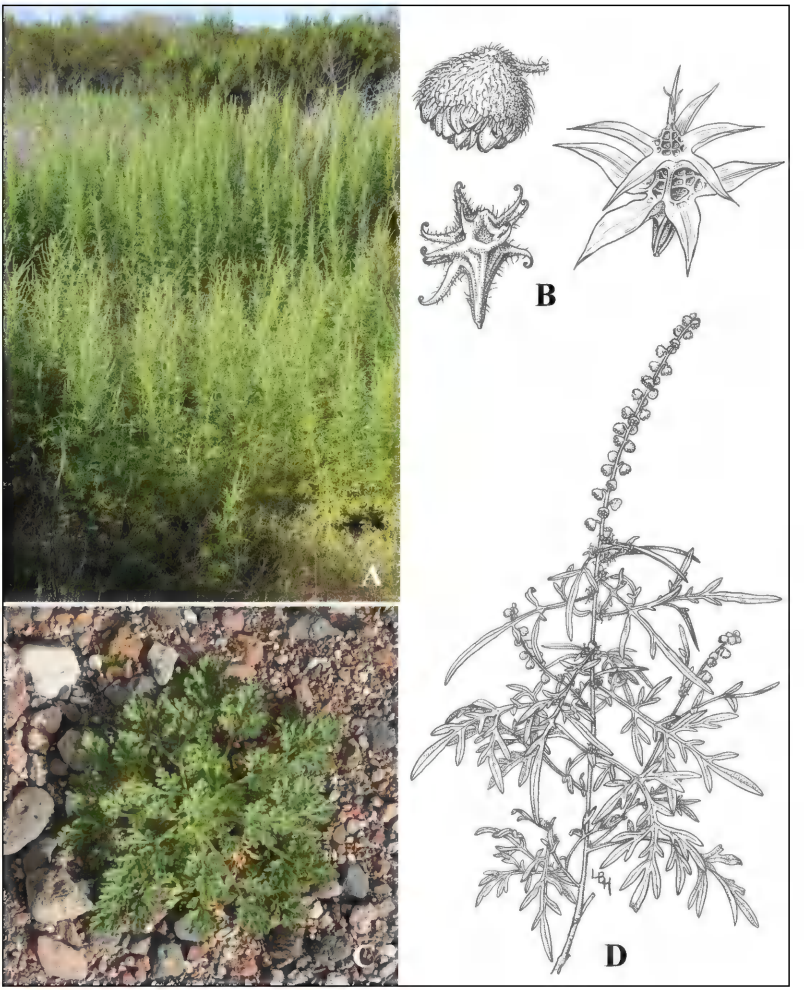

Figure 12. *Ambrosia confertiflora*. (A) Cuerda de Leña at Camino del Diablo, 26 Sep 2013. (B & D) By Lucretia Breazeale Hamilton. (C) Sandy wash bed, Pipeline Road, Sauceda Mts, 4 Mar 2009.

Herbaceous perennials from a hard, knotty base, with stout, deeply buried, woody taproots and spreading by rhizomes. Plants highly variable in size; stems often 40–75 cm tall, erect, and leafy with white, mostly appressed hairs, and sometimes reaching 1–1.5+ m in some major washes; new shoots produced in spring and/or following summer rains; the new shoots can have densely white-hairy stems and relatively large and crowded leaves; generally winter dormant. Leaves mostly alternate, often 6–17 cm long, 2–4 times pinnately divided, and gland dotted. Burs 3–4 mm long with small, straight and hooked spines. Flowering and fruiting mostly September–December, also May and June.

Locally abundant in poorly drained clayish-silty soils such as playas and dirt tanks (charcos), sandy-gravelly and silty soils of washes, and roadsides and other disturbed habitats. Also occasionally to high elevations in the Ajo Mountains in soil pockets on rocky slopes. It has been widespread in the region for more than 29,000 years.

Mainly southwestern United States to central Mexico; often weedy, its range apparently expanding.

OP: Bates Well, 17 Nov 1939, *Harbison 26151* (SD). Ajo Mountain Drive, 6.7 mi NE of Visitor Center, 2000 ft, 5 Nov 1977, *Bowers 915*. Cuerda de Leña Wash, 13 Jun 1978, *Bowers 1344*. Quitobaquito, 6 Apr 1988, *Felger 88-271*. Ajo Mt, trail above Bull Pasture, 15 m below crestline, 4090 ft, 10 Apr 2005, *Felger 05-292*. †Alamo Canyon, burs, 8130 to 29,110 ybp (5 samples).

CP: Las Playas, *Monson 10 Oct 1963*. Pinta Playa, *Simmons 4 Oct 1964*. Little Tule Well, 12 Jun 1992, *Felger 92-538*. San Cristobal Wash: 14 Sep 1992, *Felger 92-696*; Abundant, in full anthesis, 0.8-1.5+ m tall, 15 Mar 2010, *Felger*, observation. Daniels Arroyo, 27 Sep 1992, *Harlan 340*.

TA: †Butler Mts, bur, 10,360 ybp.

Ambrosia cordifolia (A. Gray) W.W. Payne
[*Franseria cordifolia* A. Gray]
Heart-leaf bursage. Figure 13.

Shrubs to about 1 m tall. Leaves mostly alternate, tardily drought deciduous; petiolate, the blades rounded to deltate, cordate at the base, often 2–5 cm long, pubescent and gland dotted, the margins coarsely toothed; new growth and young leaves often whitish pubescent. Burs 3–4 mm long, rounded to ellipsoid, tomentose and with stalked glands and straight or hooked spines. Growing and flowering during cooler months; summer dormant.

Ajo and Diablo mountains; often common on rocky slopes and in riparian canyons of the Ajo Mountains.

Southern Arizona, Baja California Sur, southwestern Chihuahua, Sinaloa, Sonora; also disjunct and adventive in Guanajuato, Querétaro, and San Luis Potosí (Rzedowski & G. Calderón de Rzedowski 1998).

OP: Alamo Ranch, 18 Mar 1933, *Shreve 6198*. Canyon Diablo, 21 Mar 1935, *Peebles & Kearney 10810*. Alamo Canyon: *Nichol 14 Mar 1939*; 3 Dec 1977, *Bowers 975*. Estes Canyon, *Galiano 27 Aug 1986* (ORPI). Arch Canyon, 10 Mar 1983, *Phillips 83-58* (ORPI). Alamo Drive, 3 mi E of Hwy 85, 19 Nov 1993, *Suzan 344* (DES).

Figure 13. *Ambrosia cordifolia*. Estes Canyon: (A) 18 Mar 2005; (B & C) 2 Mar 2008.

Ambrosia deltoidea (Torrey) W.W. Payne
[*Franseria deltoidea* Torrey]
Triangle-leaf bursage; *chamizo forrajero;* tadsad, va:gita. Figure 14.

Bushy subshrubs with slender, leafy, few-branched stems; tardily drought deciduous and summer dormant. During drought the stems and remaining leaves become covered with amber-colored resinous-sticky exudate. Leaves mostly alternate, highly variable in size; petioled; leaf blades (8) 12–50 (60) mm long, triangular-ovate, gray- to olive-green, densely short-woolly, especially during drier conditions, with age becoming sticky with glandular exudate, especially on the upper surfaces, matting the hairs so that the leaves appear glabrous. Burs 6.5–11.5 mm wide and about as

long, densely glandular, sparsely pubescent to densely woolly; spines few to many, straight and flattened to sometimes nearly terete, rarely hooked. Flowering and fruiting in spring.

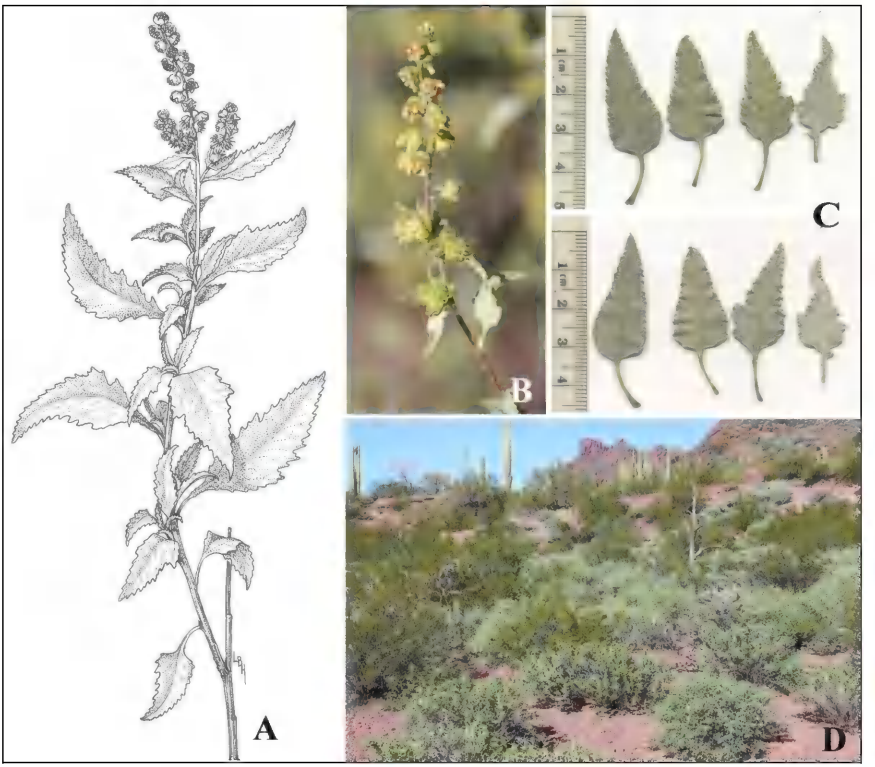

Figure 14. *Ambrosia deltoidea*. (A) By Lucretia Breazeale Hamilton. (B) Near Victoria Mine, 1 Apr 2010. (C) Upper and lower surfaces of leaves, Ajo Scenic Loop, Little Ajo Mts, 26 Mar 2014. (D) Near Alamo Canyon Campground, 12 Jan 2014 (the larger shrubs are *Larrea*).

Maximum densities are often along small drainageways, swales, or arroyos, and at the edges of xeroriparian galleries of ironwood, mesquite, and palo verde along major arroyos. Also rocky slopes, playas, clay soils, and sandy creosotebush flats, from the desert floor to peak elevations. *Ambrosia deltoidea* is one of the most widespread and abundant perennials across the much of Organ Pipe and Cabeza Prieta, but in the more xeric Tinajas Altas Region it is replaced by *A. dumosa*. A single Tinajas Altas collection in 1983 is an interesting anomaly, although, tellingly, it is noted as "rare." In nearby regions, such as northwestern Sonora, *A. deltoidea* likewise does not extend into such extremely xeric areas as does *A. dumosa* (Felger 2000). The only fossil record is from 3500 years ago.

In extreme drought the plants become leafless except for a few small, bud-like terminal leaves encased in resin. Growth ceases during the long, hot summer and the plants become dormant, even during rainy times. If temperatures drop, however, as during unusually cloudy or rainy days in

summer, some new leaves may be produced in a very short time. Luxuriant new growth may begin in mid- to late-September. As with many other major desert perennials, reproduction is episodic, with large cohorts produced under favorable conditions. The abundant rainfall delivered by Hurricane Nora in September 1997 resulted in massive numbers of new *A. deltoidea* and *A. dumosa* plants across much of Cabeza Prieta and western Organ Pipe (see Bowers 2002). These two bursages are among the most ubiquitous desert species of the region. They may live more than a century and take 30–100 years to revegetate areas heavily impacted by people (Artz 1989). During the drought of the early 2000s, widespread mortality of mature *A. deltoidea* occurred in Organ Pipe and Cabeza Prieta. *Ambrosia deltoidea* is the host plant for broomrape (*Orobanche cooperi*) and an important nurse plant for seedlings of many larger perennials such as cacti (e.g., chollas and saguaro). The branches were fashioned into a utility brush (Philip Salcido in Felger et al. 1992).

Central and southwestern Arizona, northwestern Sonora, and the Baja California Peninsula.

OP: Quitobaquito, *Nichol 3 Mar 1939*. Bates Well, 23 Apr 1942, *Cooper 546-A*. Pozo Nuevo, 17 Apr 1985, *Bennett 8774* (ORPI). S Puerto Blanco Drive, 1 mi W of Hwy 85 on, 23 Jul 1986, *Felger 86-22*. †Puerto Blanco Mts, on ridge, bur, 3480 ybp.

CP: Pinacate Lava Flow, *Duncan 29 Mar 1970* (CAB). Charlie Bell Pass, 3 Apr 1992, *Whipple 3939* (CAB). Bates Well Road at Organ Pipe boundary, 14 Sep 1992, *Felger 92-680*. 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002*.

TA: Tinajas Altas, 1200 ft, rare on granite, 0.5 m shrub, *Van Devender 26 Mar 1983*.

Ambrosia dumosa (A. Gray) W.W. Payne
[*Franseria dumosa* A. Gray]
White bursage; *chamizo*; tadsad. Figure 15.

Dwarf shrubs, often 30–80 cm tall, many branched, the branches mostly spreading. Twigs and leaves densely pubescent with white hairs, the twigs sometimes spinescent-tipped. Leaves mostly alternate, (4) 10–30 (40+) mm long, tardily drought deciduous and ultimately leafless in extreme drought; petioles prominent, often winged, more so with favorable moisture conditions; leaf blades 1–3 times pinnately dissected into small, somewhat rounded segments variable in shape depending upon moisture conditions, dull green becoming whitish with drier conditions. Male and female heads often intermixed (unique within the genus), each female flower head below a male head. Burs 7–9.5 mm wide, glandular, sometimes with sparse, slender white hairs, the spines straight and flattened. Growing, flowering and fruiting winter and spring, and sometimes in summer.

Valley plains, bajadas, and rocky slopes to the summits of the drier mountains. The fossil record in the region extends to 15,700 years ago.

Along with *A. deltoidea* and *Larrea*, white bursage is one of the most widespread and common perennials in the flora area as well as in the Sonoran and Mojave deserts (see *A. deltoidea*). Southeastern California to Baja California Sur, southern Nevada, extreme southwestern Utah, and Arizona southward to Sonora in the vicinity of Bahía Kino. Raven et al. (1968) reported sympatric diploid, tetraploid, and hexaploid chromosome levels for the species, with hexaploids restricted to California deserts, and diploids and tetraploids in the flora area (also see Seaman & Mabry 1979).

OP: "Quitovaquito," 30 Jan 1894, *Mearns 2751* (US). Puerto Blanco Mts, *Nichol 25 Feb 1939*. Armenta Well Road ½ mi W of Hwy 85, 3 Dec 1977, *Bowers 991*. †Puerto Blanco Mts, on ridge, burs, 990 & 2340 ybp.

CP: 10 mi E of Papago Well, 25 Mar 1932, *Shreve 5918*. Charlie Bell Well, *Johnson 26 Mar 1960*. San Cristobal Wash, 20 Mar 1992, *Harlan 21*. Papago Well, 26 Feb 1993, *Felger 93-137*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Lechuguilla Desert, Camino del Diablo, 28 Oct 1937, *Gentry 3523* (DES). SE of Raven Butte, bajada, 26 Nov 2004, *Felger 04-07*. 2 mi S of Tinajas Altas, 22 Nov 2008, *Felger 08-194A*. †Butler Mts, twigs, leaves, burs, 740 to 11,250 ybp (7 samples). †Tinajas Altas, leaves, burs, 1230 to 15,680 ybp (11 samples).

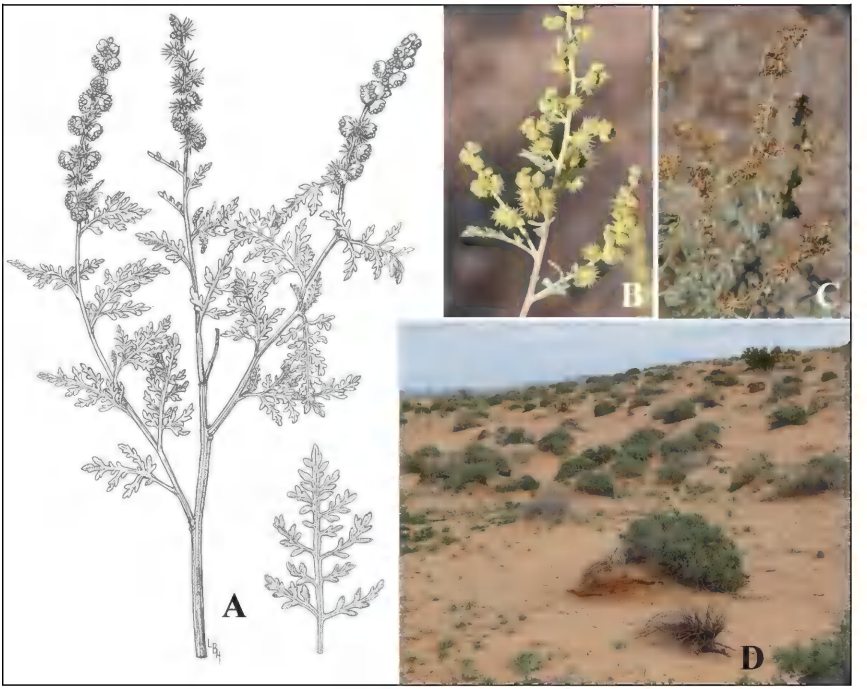

Figure 15. *Ambrosia dumosa*. (A) By Lucretia Breazeale Hamilton. (B) Hwy 85 between Ajo and Why, 8 Apr 2005. (C) Fruiting branches, Alamo Wash, 6 May 2005. (D) Dunes, 15 mi S of Sonoyta, near Mex Hwy 8, Sonora, 6 Feb 2014.

Ambrosia dumosa × A. ilicifolia

This putative hybrid appears intermediate between the presumed parents. Known in the flora area by a single record.

TA: Tinajas Altas, steep slope N of the tinajas, one plant, 20 cm tall with several branches, 19 Mar 1998, *Felger 98-136*.

Ambrosia ilicifolia (A. Gray) W.W. Payne
[*Franseria ilicifolia* A. Gray]
Holly-leaf bursage. Figure 16.

Broad, spreading shrubs, often 0.5–1 m tall, sometimes reaching 2 m across. Stems thick but scarcely woody. Leaves mostly alternate, tardily drought-killed to partly evergreen, 3.5–10 cm long, ovate, firm and holly-like, sessile, dry and rough to the touch, and glandular hairy; margins with coarse, spine-tipped teeth; dry dead leaves white and persistent. Burs (10) 15–18 mm long, densely

pubescent with glandular hairs, the spines many, curved and hooked; burs resembling a cocklebur (*Xanthium*). Summer dormant, flowering and fruiting winter and spring.

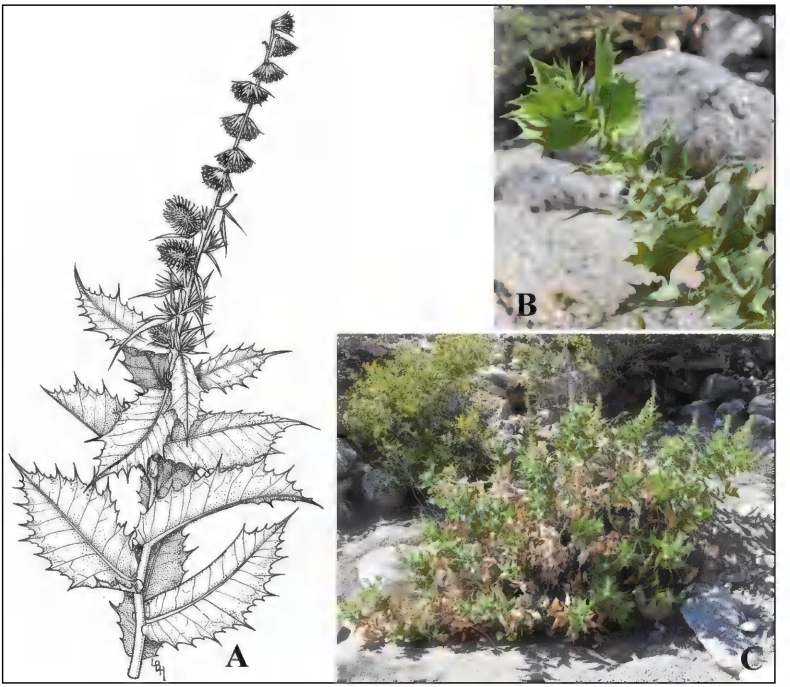

Figure 16. *Ambrosia ilicifolia*. (A) By Lucretia Breazeale Hamilton. (B & C) Wash at base of granite mountain near Mex Hwy 2, Sierra Nina (Sierra del Águila), Sonora, 17 Mar 2014.

Washes, canyon bottoms and sometimes on rocky slopes in the western part of Cabeza Prieta and in Tinajas Altas. The fossil record in the region extends to 15,700 years ago.

The dry, dead leaves rustling in the wind sound startlingly like a rattlesnake—and sidewinders are sometimes coiled beneath the dense foliage. One June day in 1994 during the bighorn sheep count, Luke Evans was concealed in a blind at Heart Tank: "At about 9:30 a.m. and less than 10 feet away, a healthy bighorn ram, about two years old, put his mouth around a stalk of dry burs and stripped them off with his teeth and chewed them up, munch, munch, munch."

Arid regions of the northern part of the Gulf of California in Sonora and Baja California, and southwestern Arizona and southeastern California.

CP: Tule Tank, *Goodding 30 Nov 1938*. Buckhorn Tank, 13 Dec 1970, *Carr 105*. Cabeza Prieta Pass, Cabeza Prieta Mts, 10 Mar 1984, *Hodgson 2727* (DES). Tule Mts, S-facing steep slope, *Rutman 16 Feb 2002*. Eagle Tank, N Pinta Tank, Buckhorn Tank, Cabeza Prieta Tanks, 12–15 Jun 1992, *Felger*, observations.

TA: Tinajas Altas, *Vorhies & Taylor 16 Apr 1924*. 1.7 km WNW of Tinajas Altas Peak, 1120 ft, 24 Jan 1999, *Baker 13308* (ASU). †Butler Mts, leaves, 740 to 11,250 ybp (7 samples). †Tinajas Altas, leaves, burs, 1230 to 15,680 ybp (17 samples).

Ambrosia monogyra (Torrey & A. Gray ex A. Gray) Strother & B.G. Baldwin
[*Hymenoclea monogyra* Torrey & A. Gray]
Slender burrobush; *jécota*; ʻi:vadhod. Figure 17.

Aromatic, resinous shrubs often 2–2.5 m tall, the branches tall and slender, mostly erect to ascending. Leaves mostly alternate, (1) 2–7+ cm long, soon drought deciduous, linear-filiform or pinnately divided into several filiform segments, the leaves or segments 0.5 mm wide, grooved above (involute), the grooves filled with minute white hairs. Burs 3.5–4 mm wide, each with a single flower enclosed in woody bracts fused at their bases, the bracts with wings in a single whorl, persistent, and papery-membranous. Flowering and fruiting in fall.

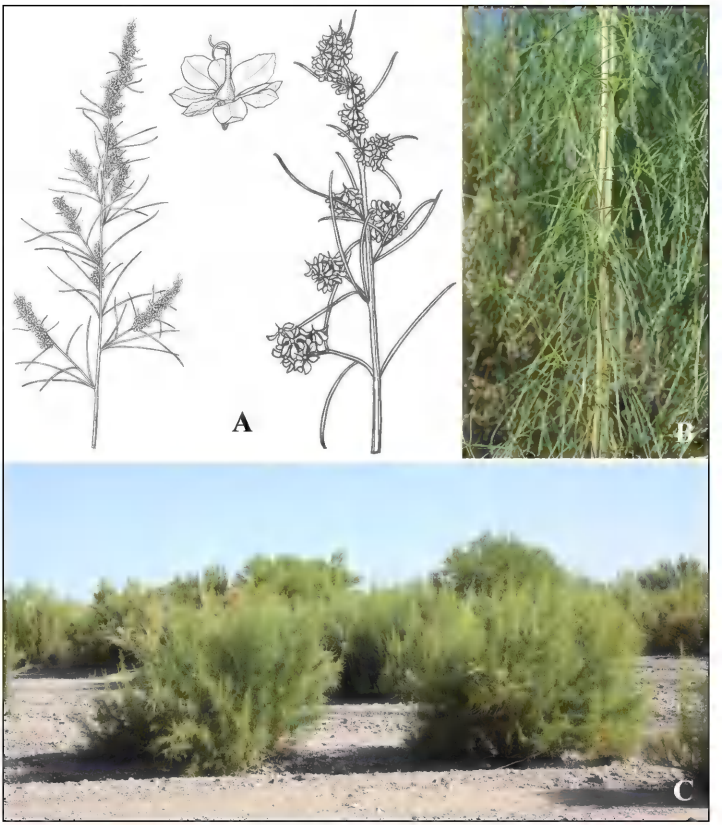

Figure 17. *Ambrosia monogyra*. (A) Young staminate (left) and pistillate (right) flowering branches and pistillate bur (center), by Lucretia Breazeale Hamilton. (B & C) Kuakatch Wash near E boundary of Organ Pipe, 23 May 2010.

Along major washes in Organ Pipe and the eastern margin of Cabeza Prieta. It can quickly recover from droughts or scouring floods.

Southwestern United States and western Mexico to Jalisco.

Teas made from this plant were used by the Seris to reduce swellings and pain in the lungs, and mixed with *Anemopsis* it was used to treat rheumatism (Felger & Moser 1985). The tall, slender branches served Gila River Pimas for roofing and for shelter walls (Rea 1997).

OP: Aguajita, 23 Oct 1987, *Felger 87-261*. Growler Wash, *Wirt 13 Oct 1988* (ORPI). Kuakatch Wash near E boundary of Monument, *Rutman 23 Oct 1999* (ORPI).

CP: Growler Wash at Organ Pipe boundary, both sides of the boundary, 12 Jun 1992, *Felger 87-261*.

Ambrosia salsola (Torrey & A. Gray) Strother & B.G. Baldwin var. **pentalepis** (Rydberg) Strother & B.G. Baldwin
[*Hymenoclea salsola* Torrey & A. Gray var. *pentalepis* (Rydberg) L.D. Benson]
Burrobrush, cheesebush; 'i:wadhod. Figure 18.

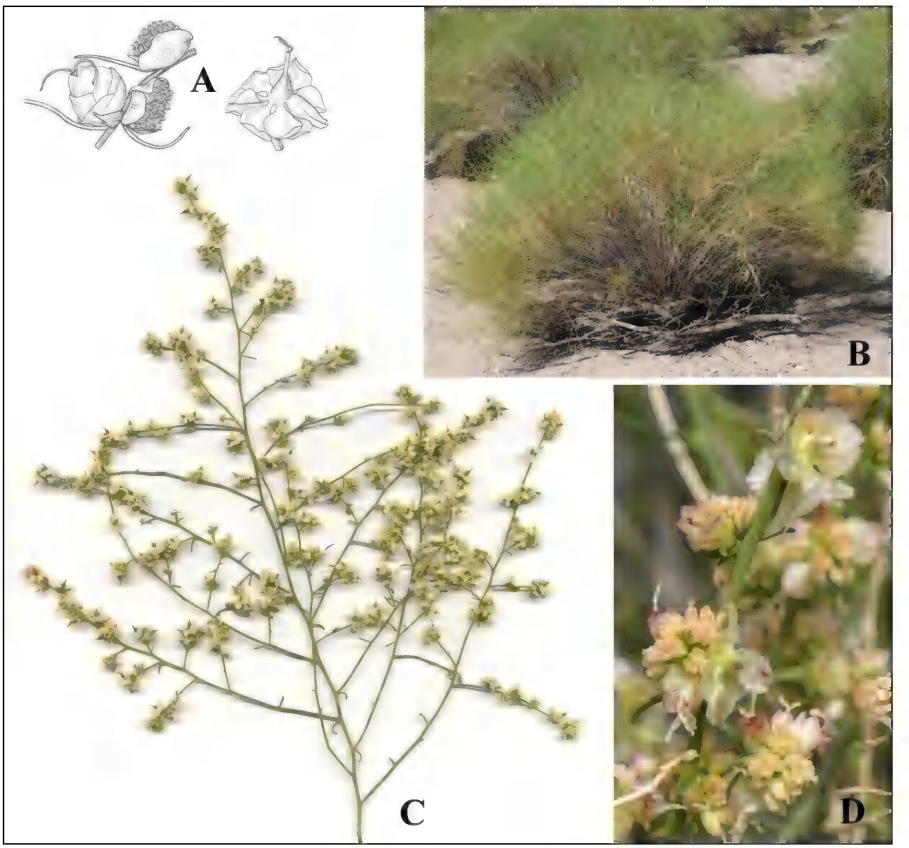

Figure 18. *Ambrosia salsola* var. *pentalepis*. (A) Flowers (left) and fruit (right), by Lucretia Breazeale Hamilton. (B) Growler Wash near Bates Well Road, 8 Oct 2006. Rasmussen Road, Ajo: (C) 25 Mar 2002; (D) 5 Mar 2005.

Aromatic, resinous shrubs to about 1 m tall, usually about as wide as tall, with many slender, spreading, interlacing branches. Leaves mostly alternate, sparsely distributed, 1–7 cm long; mostly falling as the new shoots mature. The larger leaves often with 1–4 linear-filiform segments; the upper leaves reduced and entire; the leaves or segments 0.5–0.7 mm wide, grooved above, with minute hairs as in *H. monogyra*. Burs 5–7 mm wide, with 1 floret, the bracts with wings in 1–several whorls at the middle of the bur, wings mostly 2.7–5 mm wide, about as long as wide, spreading like tiny airplane propellers. Flowering March and April. Wet plants smell like a dead animal.

Widespread and very common, mostly on sandy gravelly soils of washes, floodplains, desert flats and bajadas, and common along roadsides and disturbed habitats. Packrats collected it in Organ Pipe and the Tinajas Altas Region 7600 to 9000 years ago. The 7600-year-old Puerto Blanco Mts midden is on a slope near a high ridge; *A. salsola* does not occur there now but is found in the wash below the midden site.

Baja California and Sinaloa to Utah and Nevada; there are two varieties—var. *pentalepis* is the southern one.

OP: Quitobaquito, 3 Feb 1894, *Mearns 2768* (US). Bates Well, *Nichol 26 Apr 1939* (ORPI). 1 mi W of Lukeville, 18 Nov 1991, *Felger*, observation. Kuakatch Wash, W of Armenta Ranch, *Rutman 4 Oct 1995* (ORPI). †Puerto Blanco Mts, on ridge, involucres (burs), 7560 ybp (on a slope and this species now occurs in the wash below the midden site).

CP: Bates Wash along Papago Well Road, *Simmons 7 Mar 1963* (CAB). N side of Tule Mts, 2 Feb 1992, *Felger 92-55*. Observations: Buckhorn Tank, 14 Jun 1992, *Felger*; Papago Well, 31 Jan 1992, *Felger*. Heart Tank, 27 Feb 1993, *Felger 93-166*.

TA: Tinajas Altas: 17 Mar 1980, *Webster 24245*; 1200 ft, *Lindquist 26 Mar 1983*. †Butler Mts, bur, 8570 ybp. †Tinajas Altas, burs, 8970 ybp.

Arida, see **Leucosyris**

Artemisia – Sage or wormwood

Herbaceous perennials, usually aromatic and bitter-flavored. Leaves alternate. Inflorescences panicle-like or smaller and contracted. Flower heads small, nodding, with inconspicuous disk florets. The flowers are wind-pollinated and unusually small even for composites. Achenes fusiform; pappus none.

This genus, with perhaps 500 species, ranges across the Northern Hemisphere. Anthemideae.

1. Herbage green, the leaves uniformly green on both surfaces, glabrous or sparsely pubescent. ..... **Artemisia dracunculus**
1. Herbage whitish, the leaves bicolored, white-woolly at least on the lower surfaces. ..... **Artemisia ludoviciana**

Artemisia dracunculus Linnaeus
[*A. dracunculoides* Pursh]
Wild tarragon, tarragon; *estragón*. Figure 19.

Herbaceous perennials or subshrubs sometimes reaching 1.5 m tall, but usually shorter, rhizomatous, with many stems from a woody base, dying back in drought and in freezing weather. Herbage mildly aromatic. Leaves mostly 1–7 cm long, bright green, linear to linear oblong or linear lanceolate; margins entire or larger leaves often with linear lobes. Inflorescences leafy, many-branched panicles with numerous flower heads; the heads 2–3 mm long, globose. Phyllaries green with translucent margins. Achenes 0.5–0.8 mm long. Flowering at least in fall.

Ajo Mountains, mostly at higher elevations and in larger canyons. The nearest populations are in the Quinlan and Baboquivari mountains. *Artemisia dracunculus* in Arizona and Sonora generally occurs above and beyond the desert. Apaches and others gathered the achenes as a food resource.

North America from Alaska and Canada to northern Mexico and in Eurasia. The cultivated culinary herb tarragon is from aromatic Eurasian populations.

Figure 19. *Artemisia dracunculus*. Alamo Canyon above Alamo Well: (A) Reproductive branch, 9 Sep 2013; (B) Reproductive plant, 15 Sep 2013; (C) staminate heads, 3 Sep 2014; (D) Vegetative stem, 6 Feb 2013; (E) Vegetative plant, 1 Feb 2014.

OP: Alamo Canyon: Rocky bottoms, 17 Dec 1945, *Goodding 484-45*; South Fork, 690 m, herb to 1.5 m tall, stems branched only at the base, with *Solanum douglasii, Baccharis, Prosopis*, 17 Oct 1987, *Baker 7566* (ASU); In wash, *Wirt 14 Oct 1989*.

Artemisia ludoviciana Nuttall subsp. **albula** (Wooton) D.D. Keck
Western mugweed, white sage; *estafiate*. Figure 20.

Herbaceous perennials from rhizomes, the stems slender and arching or nearly straight, 0.5–0.8 m long, dying back in drought and in freezing weather. Herbage usually white woolly. Leaves mostly 3–4.5 cm long (lowermost early-season leaves to 7 cm long), linear to linear-lanceolate, with a few large teeth, woolly on both surfaces, grayish to whitish green, bicolored, and entire and reduced above. Flower heads 3–3.5 mm long, in elongated leafy or bracteate terminal panicles. Phyllaries thin, woolly outside, persistent, outer ones smaller and greener, inner ones 2.5–3.5 mm long, green with broad, translucent-membranous margins. Achenes 0.9–1.3 mm long. Flowering late spring and probably with summer rains.

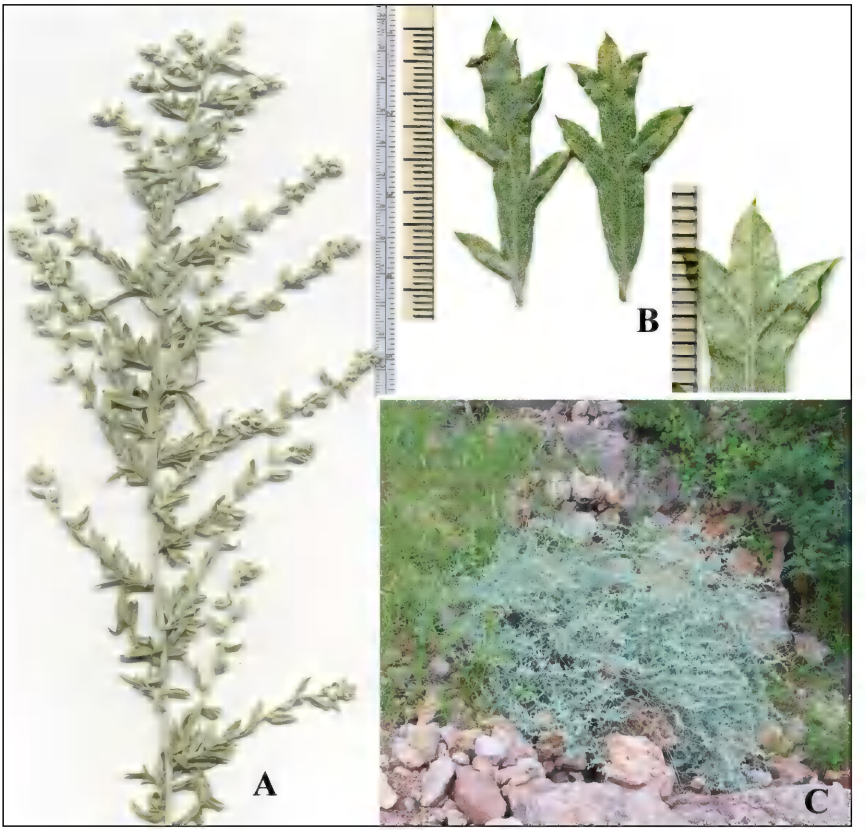

Figure 20. *Artemisia ludoviciana* subsp. *albula*. Alamo Canyon near the well: (A) 10 Sep 2008; (B) Cauline leaves, upper surface (left) and underside of leaf (right), 4 Apr 2015; (C) 19 Sep 2014.

Rocky slopes, canyons, and arroyos in the Ajo and Diablo Mountains, especially at higher elevations. The fossil record extends to 32,000 years in Organ Pipe. It was in the Tinajas Altas Mountains between 11,100 and 18,750 years ago.

This species ranges from Alaska and Canada to northern Mexico; it is highly variable with a confusing array of subspecies and varieties; subsp. *albula* is in southwestern United States and northwestern Mexico.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939*. Alamo Canyon, 18 Dec 1939, *Harbison 26269*. Bull Pasture, 5 Nov 1977, *Bowers 943*. Arch Canyon, 2 Dec 1990, *Felger 90-537*. Diablo Mts, 2647 ft, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-9*. †Alamo Canyon, leaves, 14,500 to 32,000 ybp (3 samples). †Montezuma's Head, leaves, 14,500 ybp.

TA: †Tinajas Altas, leaf fragments, 11,040 to 18,700 ybp (4 samples).

††**Artemisia tridentata** Nuttall
Big sagebrush

Shrubs, highly variable in size. Sagebrush species/taxa seem to have been widespread in sub-Mogollon Arizona pinyon-juniper-oak woodlands of the late Wisconsin. Based on the midden leaves it is not possible to determine which member of the *tridentata* complex was present.

Members of the *A. tridentata* species complex presently occur above the Mogollon Rim in Arizona. Bigelow sage, *A. bigelovii* A. Gray, is a small many-stemmed shrub of dry mesas and slopes, often with pinyon. Black sage, *A. nova* A. Nelson, is a subshrub that grows in rockier habitats. Big sagebrush, *A. tridentata*, is a larger shrub characteristic of deeper soils of larger valley bottoms (e.g., Kearney & Peebles 1951).

OP: ††Alamo Canyon, wood, leaves, involucres, 14,500 to 32,000 ybp (3 samples). Montezuma's Head, wood, leaves, involucres, 13,500 to 29,110 ybp (4 samples).

Aster intricatus, see **Leucosyris carnosa**

Baccharis

Shrubs with resinous herbage. Leaves alternate. Male and female flowers on separate plants (those in the flora area); flower heads of white disk florets. Phyllaries graduated. Pistillate pappus of numerous soft capillary bristles; staminate pappus of fewer, firmer bristles. Achenes small, light colored, 5–10-ribbed.

North America to South America, where it is especially diverse; mostly warm temperate, desert, and tropical regions; 350+ species. Astereae.

1. Leaves 5–12 cm long..... **Baccharis salicifolia**
1. Leaves less than 4 cm long.

2. Shrubs usually as broad as or broader than tall; herbage dull green, moderately or not glutinous; twigs brown; achenes 5-ribbed..... **Baccharis brachyphylla**
2. Shrubs usually taller than wide; herbage yellow-green and glutinous-sticky; twigs green; achenes 10-ribbed..... **Baccharis sarothroides**

Baccharis brachyphylla A. Gray
Short-leaf baccharis. Figure 21.

Sprawling shrubs, often 0.5–1.5 m tall or wide, densely branched with broom-like green stems. Herbage scabrous. Leaves 8–12 mm long, narrowly spatulate to linear-lanceolate, entire or larger ones sometimes toothed. Flower head 4–7 mm wide; phyllaries green with broad, scarious margins, the larger phyllaries 4–5 mm long; flowers white. Achenes 2.7–3.5 mm long, reddish brown to reddish, narrowly ellipsoid to cylindrical, 5-ribbed, the pappus bristles 3–7 mm long, white to pale tan. Flowering mostly late spring to early fall.

Margins of gravelly-sandy washes and on rocky slopes; locally common at the eastern margin of Cabeza Prieta and the northwestern portion of Organ Pipe and occasional elsewhere in Organ Pipe. Localized and uncommon at Tinajas Altas where it is seen at higher elevation, generally in canyon bottoms. Flowers often attracting hoards of insects including bombyliids, digger wasps, honey bees, small bees, great purple hairstreak, snout butterflies, and large tarantula hawk wasps.

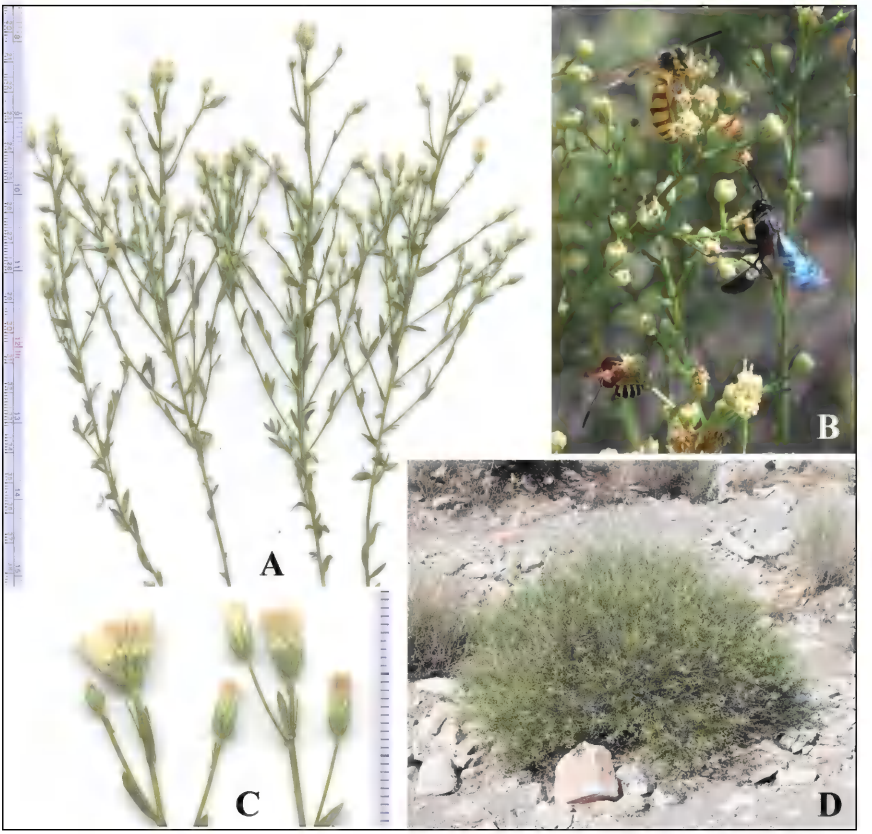

Figure 21. *Baccharis brachyphylla*. (A, C, & D) Canyon on N side of Little Ajo Mts, 2 Oct 2013; (B) Bates Well Road, N of Bates Well, 26 Sep 2013.

Southeastern California, Arizona, northern Baja California, and Sonora.

OP: 5 mi N of Visitor Center in Cherioni Wash, *Warren 10 Nov 1983*. 0.5 mi W of Growler Pass, 8 Mar 2003, *Rutman 2003-271* (ORPI). Bates Mts, drainage N side of northernmost hills, 23 Mar 2003, *Rutman 2003-400* (ORPI). Cuerda de Leña Wash, 0.5 mi S of Organ Pipe northern boundary, xeroriparian, 7 Oct 2006, *Rutman 20061007-17*.

CP: 0.8 mi E of Little Tule Well, 12 Jun 1992, *Felger 92-533*. Daniels Arroyo, 18 Jan 2003, *Felger 03-20*.

TA: Tinajas Altas: 5 Dec 1935, *Goodding 1186*; Canyon above the tinajas, 26 Oct 2004, *Felger 04-79*. Frontera Canyon, canyon bottom among rocks, *Felger 98-108*.

Baccharis salicifolia (Ruiz & Pavón) Persoon

[*B. glutinosa* Persoon, misapplied; the name *B. glutinosa* actually applies to *B. douglasii* de Candolle, an herbaceous perennial]

Seepwillow; *batamote*; susk. Figure 22.

Shrubs to 2+ m tall, glabrous, with leafy stems, the new growth resinous. Leaves 5–8 (12) cm long, lanceolate, willow-like, usually toothed, glandular-punctate, conspicuously glutinous-sticky with a distinctive resinous odor, evergreen or shriveling in drought. Phyllary margins erose-membranous, the larger (inner) phyllaries 2–2.8 mm long; flowers white. Achenes 1–1.1 mm long, 5-ribbed; pappus bristles 4–5.5 mm long. Staminate pappus bristles barbellate or sub-plumose near tip. Mostly growing and flowering during warmer months.

Springs, arroyo bottoms and washes with at least temporary water or wet soil; at a few waterholes, riparian canyons, and wetlands in Organ Pipe and Cabeza Prieta. MacDougal found it at Walls Well in 1907 but it is no longer there; at that time water was pumped for mining and ranching and enough water spilled to support wetland plants such as seepwillow. The involucral bracts are persistent and from a distance can be mistaken for flowers.

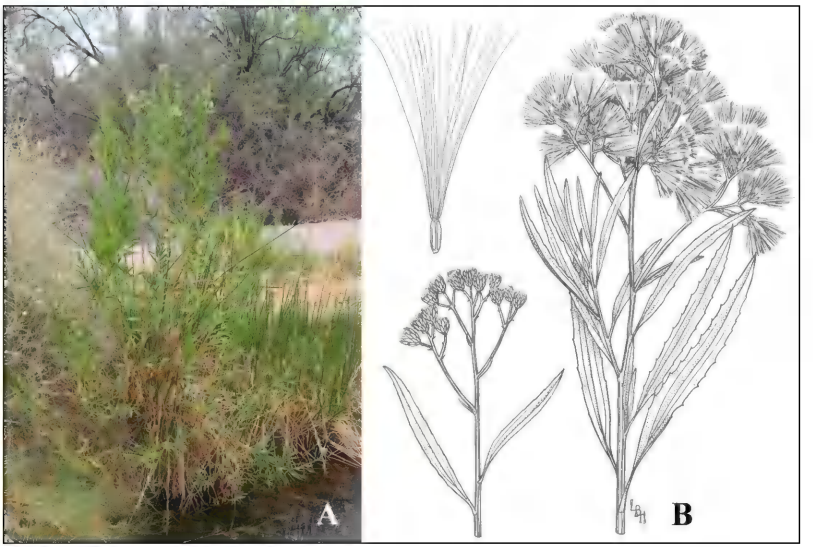

Figure 22. *Baccharis salicifolia*. (A) Quitobaquito, 17 Jul 2013. (B) By Lucretia Breazeale Hamilton.

Southwestern United States to South America.

Yumans cooked the young shoots as an emergency food (Castetter & Bell 1951). The plant was used for many medicinal purposes by different people, including for treating baldness and eye ailments, and for "women's hygiene" (Bean & Saubel 1972; Felger & Moser 1985; Moerman 1998). Gila River Pimas used seepwillow for house walls if arrowweed (*Pluchea sericea*) was not available (the pithy stems of seepwillow were less desirable than those of arrowweed, which are solid; Rea 1997).

OP: Quitobaquito: *Nichol 28 Apr 1939*; *Van Devender 30 Aug 1978*. Growler Canyon, 30 Mar 1979, *Bowers*, observation; see *Senecio flaccidus*, *Bowers 1600*). South Alamo Canyon, *Hustafa 24 Jun 1987* (ORPI).

CP: Agua Dulce Spring, damp sand at spring, one shrub, 13 Jun 1992, *Felger 92-576*. Redtail Tank, 12 Jun 1992, *Felger*, observation. Cameron Tank, E boundary of Cabeza Prieta, "the pond is ringed with seepwillow and littered with *novellas* left by job-seeking border crossers," 1 Mar 2000, *Malusa*, observation (the pond is on BLM land but some of the seepwillows are on the Cabeza Prieta side of the boundary).

Baccharis sarothroides A. Gray
Desert broom; *escoba amarga, romerillo*; susk kuagig. Figure 23.

Shrubs often 2–2.5 m tall, with numerous upright, leafless or sparsely leaved, green, broom-like branches. Twigs angled or striate-ridged. Herbage dotted with short-stalked, glandular hairs producing copious sticky-glutinous exudate that soon covers the hairs and coats the leaf surfaces. Leaves quickly deciduous; new growth with linear to linear-lanceolate leaves reaching 1–3 (4) cm, the larger leaves often minutely toothed (dentate); most leaves much smaller or reduced to scales. Phyllary margins erose to ciliate-membranous, the outer phyllaries broadly ovate, the inner ones linear, 6.5–7.5 mm long. Flowers white; mostly October and November. Achenes 1.5–2.7 mm long, 10-ribbed, the pappus bristles white, 9–11 mm long.

Mostly along large dry watercourses, at some waterholes, and disturbed habitats including roadsides; scarce in Cabeza Prieta, in the eastern margin including Growler Wash and disturbed habitats on Childs Mountain, and more common and widespread in Organ Pipe. Also along Coyote Wash east of Tinajas Altas.

Northwestern Mexico in Baja California, Baja California Sur, Sinaloa, and Sonora and southwestern United States in Arizona, California, Nevada, New Mexico, and western Texas.

The branches were made into brooms by Gila River Pimas (Rea 1997). The Tohono O'odham made arrow foreshafts from the straight stems although creosotebush was preferred (Castetter & Underhill 1935). Tea made from the leaves was taken by Seris as a remedy for colds, to help with weight loss, and as a contraceptive (Felger & Moser 1985). Branches were used to form one layer of the roof on the traditional O'odham dwelling, or *ki*, such as the one located at Armenta Ranch.

OP: Quitobaquito, "*romerio*," 5 Feb 1894, *Mearns 2775* (US). Bates Well, *Nichol 26 Apr 1939* (ORPI). Cipriano Well, *Nichol 27 Apr 1939* (ORPI). Alamo Canyon, *Beale 15 Mar 1986* (ORPI). Aguajita, 23 Oct 1987, *Felger 87-269A*.

CP: Childs Mt, E. slope, *Simmons 30 Oct 1962*. 1 mi S of Bates Well Road on road to Jose Juan Tank, 14 Sep 1992, *Felger 92-706*. Growler Wash at Organ Pipe boundary, 26 Feb 1993, *Felger 93-78*. Red Tail Tank, 12 Jun 1992, *Felger*, observation.

TA: Coyote Water, 25 Oct 2004, *Felger 04-26, 04-27*.

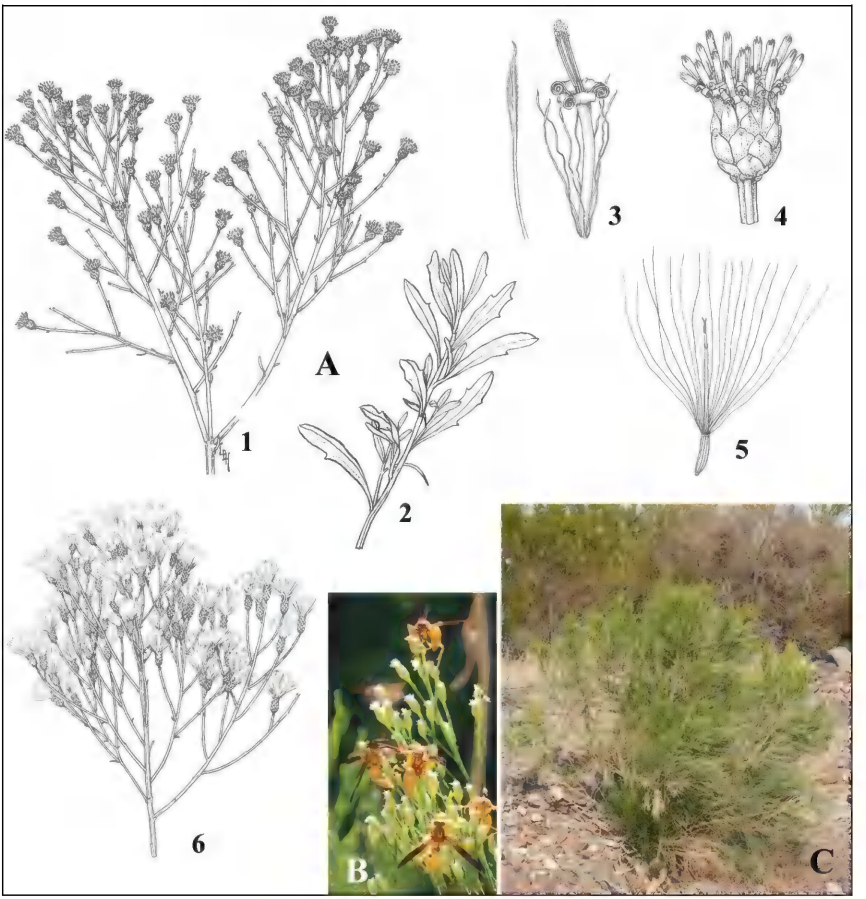

Figure 23. *Baccharis sarothroides*. (A): (1) staminate flowering branch, (2) leafy branchlet, (3) staminate floret, (4) pistillate flower head, (5) pistillate floret, and (6) pistillate flowering branch, by Lucretia Breazeale Hamilton. (B) Wasps on flowers, Alamo Canyon near Alamo Well, 17 Oct 2013. (C) Alamo Wash, 4 Mar 2009.

Bahiopsis

Southwestern United States and northwestern Mexico; 12 species. A genus segregated from *Verbesina*. Heliantheae, Helianthinae.

Bahiopsis parishii (Greene) E.E. Schilling & Panero
[*Viguiera parishii* Greene. *V. deltoidea* A. Gray var. *parishii* (Greene) Vasey & Rose]
Parish's goldeneye; *ariosa*. Figure 24.

Shrubs to 1.6 m tall with many slender and brittle stems. Herbage and phyllaries with coarse, stiff hairs and sub-sessile glands. Leaves opposite or the upper ones sometimes alternate, (2) 3–5 (7) cm long, petioled, the blades ovate to broadly triangular-ovate. Phyllaries graduated, ovate to

lanceolate and somewhat hardened basally, the larger, inner phyllaries 5.5–10 × 1.5–2 mm and usually abruptly narrowed above. Flower heads with bright yellow ray and disk florets, the rays often 1.2–1.5 cm long, (2-) 3-toothed at tip, soon deciduous. Achenes (2.8) 3.4–4 mm long, obpyramidal, moderately compressed, with ascending to appressed white hairs, the margins ciliate but otherwise not differentiated from the body; pappus of several or more persistent scales, some awn-tipped and others with ragged margins. Flowering after rains, at least March–May and October.

Widespread across the flora area, including canyons, and coarse, well-drained soils of lower bajadas and mountain slopes to the summits, and in larger washes in the eastern part of the flora area. It has been in Organ Pipe mountains for at least 21,900 years.

Deserts in western and central Arizona, western Sonora, Baja California, Nevada, and southeastern California.

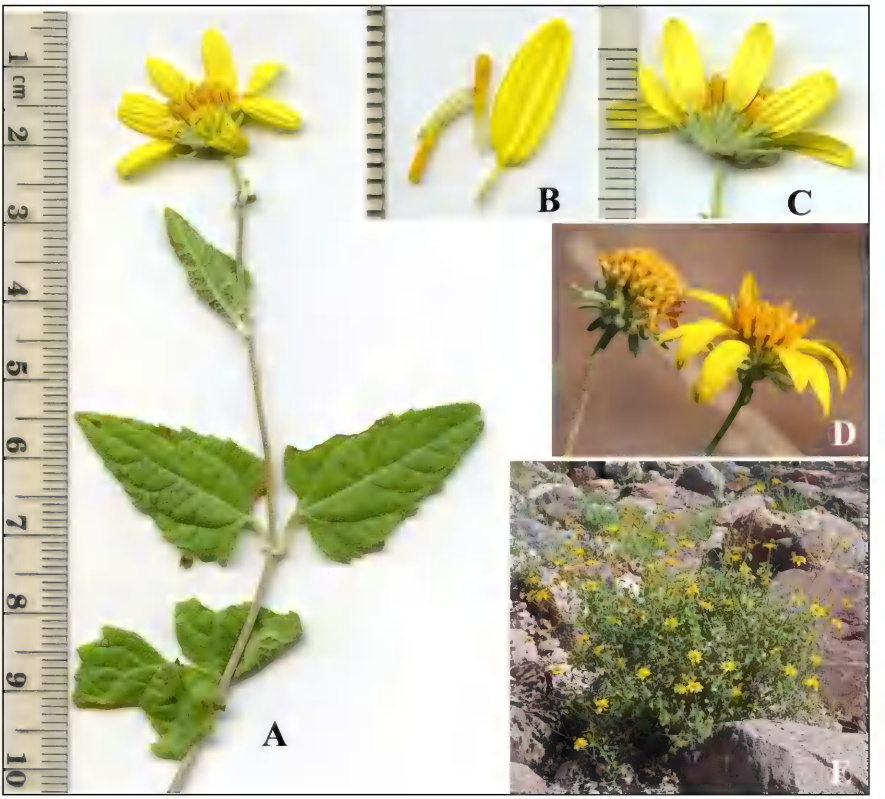

Figure 24. *Bahiopsis parishii*. Bull Pasture Trail: (A–C) 8 Aug 2014; (D) 28 Feb 2009. (E) Alamo Canyon, 26 Feb 2014.

OP: Bates Well, 19 Nov 1939, *Harbison 26168*. Canyon Diablo, 21 Mar 1941, *Peebles 10821*. Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 546*. Estes Canyon, *Hesselberg 10 Apr 1966*. Trail from The Cones to

Mount Ajo, 4090 ft, 10 Apr 2005, *Felger*, observation. Puerto Blanco Mts, near N Puerto Blanco Drive, 21 Sep 2013, *Rutman 20130921-14*. †Alamo Canyon, twigs, achenes, 1150 ybp (4 samples). †Montezuma's Head, twigs, achenes, 20,490 & 21,840 ybp. †Puerto Blanco Mts, on ridge, achenes, 3400 to 9860 (5 samples).

CP: Pinacate Plateau, Camino del Diablo, Arroyo bank, 28 Oct 1937, *Gentry 3506* (DES). Tule Well region, *Goodding 24 Nov 1934*. Buckhorn Tank, *Monson 22 Dec 1954* (CAB). Childs Mt, 9 Apr 1993, *Felger 93-295*. 1.5 mi S of Heart Tank, *Jansen 23 Jan 2003*. Sierra Pinta, summit, *Cain 15 Nov 2003*. Observations: N side of Tule Mts, 2 Feb 1992, *Felger*; Cabeza Prieta Tanks, Buck Mountain Tank, 14 & 15 Jun 1992, *Felger*.

TA: Borrego Canyon, 3 Feb 1990, *Felger*, observation. Tinajas Altas, 26 Feb 2004, *Felger 04-84*.

Baileya – Desert marigold; *tecomblate*

Ephemerals or short-lived herbaceous perennials, densely white woolly and with glistening orange glands even on the corollas and achenes. Leaves in basal rosettes and alternate on stems, pinnatifid below, generally reduced above. Phyllaries sub-equal, linear-lanceolate, green beneath the woolly hair. Flower heads on long peduncles or few-leaved stems, with bright yellow ray and disk florets, the ray florets fertile, large and showy, persistent and somewhat papery, bent down in age; disk florets many, fertile. Achenes papillose-hispid, conspicuously ribbed, clavate-cylindrical to moderately compressed laterally, truncate at apex; pappus none. The flowers attract numerous butterflies.

Southwestern United States and northern Mexico, especially in deserts and arid regions; 3 species. Heliantheae, Gaillardinea.

1. Ray florets 5–7; heads 6 mm wide not including rays, mostly loosely cymose. ..... **Baileya pauciradiata**
1. Ray florets 20–50; heads 10 mm or more in width not including rays, mostly single on an elongate peduncle.

2. Stems usually leafy only at base or below the middle; heads usually 3.5–4 cm wide (including rays); achene ribs all more or less similar..... **Baileya multiradiata**
2. Stems leafy to the middle or above; heads usually 2.4–3.2 cm wide (including rays); achene ribs conspicuously unequal, larger at the achene angles..... **Baileya pleniradiata**

Baileya multiradiata Harvey & A. Gray
Many-flowered desert marigold; gi:ko. Figure 25.

Ephemerals to short-lived perennials. Leaves mostly in apparent basal rosettes and below the middle of the stems, the larger leaves 5.5–12 cm long. Flowering stems mostly 20–30 cm tall, with reduced leaves below and leafless above, with 1 head per stem. Phyllaries 5.5–6.5 mm long, linear-lanceolate. Flower heads often 3.5–4 cm wide including rays; the rays many, bright yellow, 15–20 × 5–8 mm, the apex conspicuously 3-toothed. Style branches truncate to slightly rounded at tips. Achenes 3.5–3.8 mm long, the ribs essentially all alike and of relatively low relief. Growing and flowering primarily in spring.

Seasonally common along Hwy 85 and widely scattered in the northern part of Organ Pipe and lower-elevation margins of the Ajo and Santa Rosa mountains, and the eastern part of Cabeza Prieta. Often along roadsides, washes, swales, and bajadas.

Northern Mexico and southwestern United States.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939*. Alamo Canyon, 2000 ft, *Tinkham 19 Apr 1942*. Bates Well, roadside and desert flats, 12 Mar 2003, *Felger 03-305*. Foothills of Puerto Blanco Mts, 21 Sep 2013, *Rutman 20130921-13*.

CP: Bates Well Road at 4.5 mi W of Organ Pipe boundary, 15 Sep 1992, *Felger 92-747*. Daniels Arroyo at Charlie Bell Road, 25 Feb 1993, *Felger 93-74*.

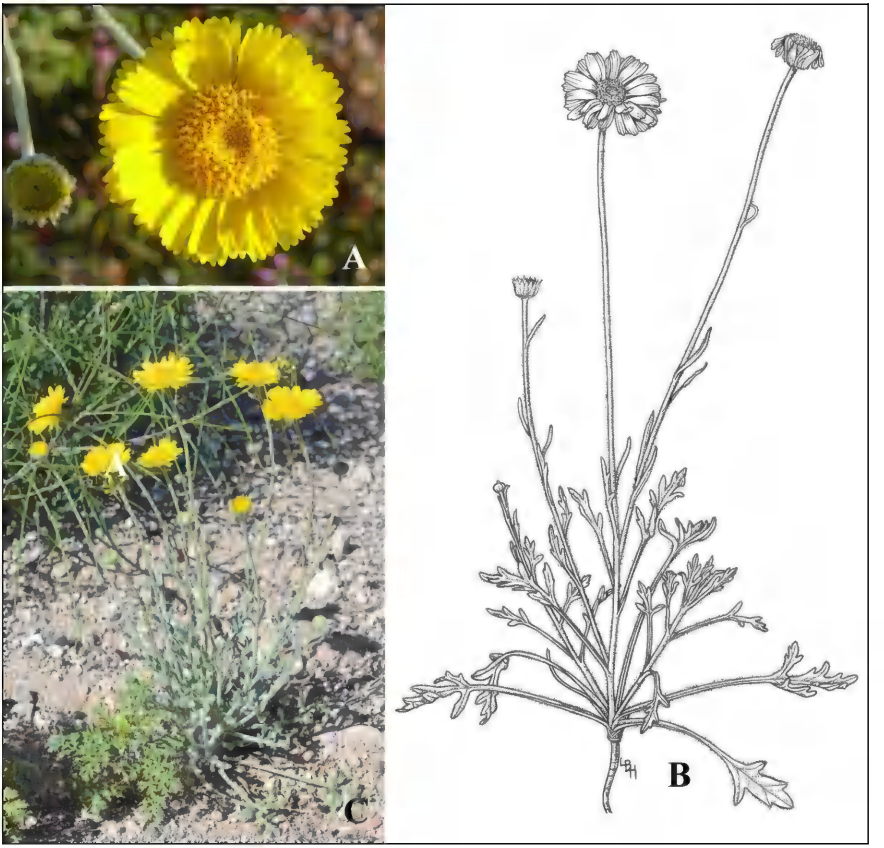

Figure 25. *Baileya multiradiata*. (A) Gu Vo Road near Kuakatch, 6 Feb 2005. (B) By Lucretia Breazeale Hamilton. (C) Ajo, 8 Mar 2015.

Baileya pauciradiata Harvey & A. Gray ex A. Gray
Few-flowered desert marigold.

Drought-stunted plants 10–15 cm tall with a single stem, or sometimes many-stemmed to 30 cm tall in seasons of exceptional rainfall. Larger leaves (3) 5–12 cm long. Stems usually several-branched, with several to many heads, the peduncles 1–3.5 cm long. Phyllaries 3.5–4.5 mm long. Heads 1.5–2 cm wide including rays, the rays 5–7 in number, 6–10 × 3.5–7.5 mm; flowers pale yellow (paler than those of *B. pleniradiata*). Achenes 3.5–4.5 (5) mm long, the ribs conspicuous and more or less equal.

Not known from the flora area but might be found along the southwestern margin of the area. Common on sandy soils and dunes across much of the adjacent Gran Desierto in northwestern Sonora (Felger 2000); sometimes growing intermixed with *B. pleniradiata*.

Baileya pleniradiata Harvey & A. Gray
Woolly desert marigold. Figure 26.

Plants mostly 10–45 cm tall. Larger leaves mostly 3.5–10 cm long (sometimes 15–30 cm long on especially robust plants). Stems several-branched, mostly with several heads, the flowering stems often 2–14 cm long. Flower heads usually 2.4–3.2 cm wide including rays, or much smaller on drought-stunted plants. Phyllaries 3.5–4.5 mm long. Rays many, pale yellow, 7.5–10 × 3.6–8.5 mm, 3-toothed to rounded-truncate at apex tip. Style branches pointed (acute). Achenes 2.5–3.5 (3.8) mm long, the ribs unequal.

Seasonally common and sometimes abundant on sandy soils including dunes in lowlands from the western part of Organ Pipe to Tinajas Altas.

Sonoran and Mojave deserts in southwestern Arizona, southeastern California, northwestern Sonora, and Baja California.

OP: 1 mi E of Quitobaquito, 13 Apr 1941, *McDougall 88*. Between Quitobaquito and Williams Spring, 10 May 1979, *Bowers 1718*. Flats W of Bates Mts, 31 Mar 1978, *Bowers 1171*.

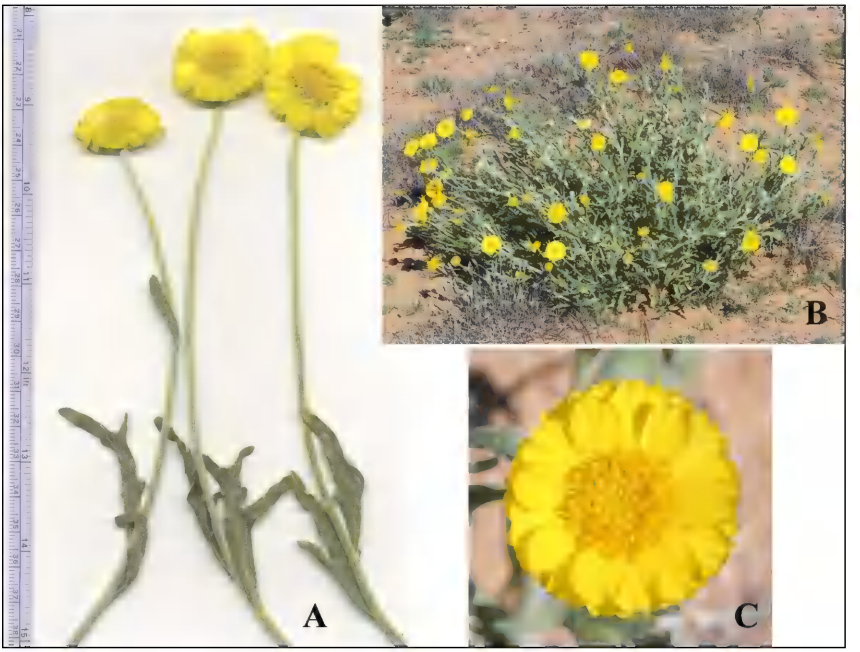

Figure 26. *Baileya pleniradiata*. (A & B) Pinta Sands, Cabeza Prieta, 11 Feb 2014. (C) Dunes S of Sierra Blanca, Pinacate Reserve, Sonora, 17 Feb 2008.

CP: Dunes 8 mi NW of Las Playas, Mexican Border, 15 Apr 1941, *Benson 10782*. Papago Well, *Engard 2052* (DES). West Pinta Sands, 27 Nov 2007, *Felger 07-547*.

TA: Butler Mts, *Van Devender 27 Mar 1983*. W side of Tinajas Altas Mts, *Felger 05-48*. Frontera Canyon, Mexico border, 18 Mar 1998, *Felger*, observation.

Bebbia

Two species; *Bebbia atriplicifolia* (A. Gray) Greene occurs in Baja California Sur. Heliantheae, Galinsoginae.

Bebbia juncea (Bentham) Greene var. **aspera** Greene
Sweetbush, chuckwalla delight; hauk 'u's. Figure 27.

Figure 27. *Bebbia juncea* var. *aspera*. (A) Canyon, N side of Little Ajo Mts, 2 Oct 2013. (B) Estes Canyon, 8 Sep 2014. Alamo Wash near Hwy 85: (C) leaves from new shoot, 21 Jan 2013; (E) 7 May 2006. (D) Aguajita Wash at Mex Hwy 2, Sonora, 2 Aug 2014.

Globose, weakly wooded shrubs or subshrubs, intricately branched with slender, brittle stems. Branches and leaves opposite, or alternate above; herbage scabrous. Foliage sparse, quickly drought-deciduous, plants leafless or nearly so much of the year; leaves mostly sessile, reaching 3–5.5+ cm long, but mostly smaller, linear to linear-oblanceolate, usually entire or the larger leaves with 1–several lobes. Flowers heads on long peduncles or stems, of disk florets, yellow and pleasantly fragrant, attracting numerous butterflies and many other insects. Achenes club-shaped, 2.3–3 mm long; pappus bristles plumose. Flowering response non-seasonal.

Common and widespread nearly throughout the flora area, especially on hot, dry bajadas, washes and canyons, and rocky slopes. It has been in the region for at least 10,800 years.

Southwestern United States and northwestern Mexico. Variety *juncea* occurs on the Baja California Peninsula.

OP: Ajo Mts: *Goodding 21 Nov 1934*; *Nichol 3 Jun 1937*. 10 mi S of Bates Well, 5 Mar 1940, *Benson 9907*. Dos Lomitas, 28 Jan 1978, *Bowers 1010*. Aguajita, 6 Apr 1988, *Felger 88-272*. †Puerto Blanco Mts, on ridge, achenes, 7560 to 9070 (3 samples).

CP: Heart Tank, *Simmons 2 Oct 1963*. Salazaria Wash, 12 Apr 1992, *Harlan 211*. Christmas Pass, 13 Apr 1992, *Harlan 273*. Observations: Heart Tank, 14 Jun 1992, *Felger*; Childs Mt, 2845 ft, 18 Aug 1992, *Felger*.

TA: Tinajas Altas, *Van Devender & Davis 5 Mar 1983*. Camino del Diablo, N of Raven Butte, 25 Oct 2004, *Felger 04-06*. Surveyors Road, E side Tinajas Altas Mts, 22 Nov 2008, *Felger 08-199*. †Butler Mts, achenes, 8160 ybp. †Tinajas Altas, achenes, 4010 to 10,750 ybp (8 samples).

Brickellia – Brickell-bush

Small shrubs. Leaves alternate or opposite, and petioled. Flower heads of disk florets. Phyllaries in several series, prominently striated (striped or ribbed), with scarious margins. Achenes slender, 10-ribbed; pappus of many persistent capillary bristles.

Central America and North America; 100 species. Eupatorieae.

1. Leaves oblanceolate, mostly narrowly so, 3 mm or less in width, the margins entire, the leaf blade and petiole not well-differentiated…… **Brickellia frutescens**
1. Leaves broadly ovate with toothed margins, mostly more than 5 mm wide, the petiole and blade conspicuously differentiated.

2. Leaves opposite (sometimes with some alternate leaves), often hastate ("eared" at base). …… **Brickellia coulteri**
2. Leaves mostly alternate (often sub-opposite on young growth), not hastate.

3. Bark shredding in thin strips; leaves mostly less than 2.5 cm long, the petioles less than ¼ as long as leaf blades; blades rigid, relatively thick, with spinescent teeth; achenes 4–6 mm long. …… **Brickellia atractyloides**
3. Bark not shredding; leaves mostly more than 2.5 cm long, the petioles ⅓ as long as leaf blades; blades sometimes thick but not rigid, toothed but not spinescent; achenes 3 mm long. …… **Brickellia californica**

Brickellia atractyloides A. Gray var. **atractyloides**
Spiny-leaf brickell-bush. Figure 28.

Subshrubs to about 30 (80) cm tall; stems slender, the bark shredding in thin strips. Herbage, peduncles, and phyllaries short glandular-pubescent or glabrate or glabrous, especially with age. Leaves mostly alternate, mostly 1.5–2.5 cm long, short petioled, the blades broadly ovate to nearly

triangular, firm with stout spinescent teeth; dry leaves moderately persistent. Heads many-flowered, solitary, on stout peduncles 2–5 cm long. Outer phyllaries 3.5–5 mm wide, leaf-like, broadly ovate, the inner phyllaries linear, 12–15 mm long. Flowers pale yellow and purplish. Achenes 4–6 mm long, blackish, with short white hairs; pappus 6–10 mm long. Flowering at least February and March.

Granitic mountains, often in rock crevices and canyon walls; western part of Cabeza Prieta and the Tinajas Altas Mountains; seldom common. Also on extrusive volcanic substrates in the Sauceda Mountains northeast of Organ Pipe. It has been in the Tinajas Altas Mountains for at least 15,700 years.

Western and central Arizona, northwestern Sonora, southeastern California, Colorado, Nevada, and Utah. Also two other varieties.

CP: Heart Tank, *Weaver 28 Apr 1970* (ASU). Eagle Tank, 13 Jun 1992, *Felger 92-583*. Tule Mts, N-facing canyon of granite, *Rutman 16 Feb 2002*.
TA: Tinajas Altas: *Vorhies 16 Apr 1924*; 29 Mar 1930, *Harrison 6578*. Borrego Canyon, N-facing granitic slope, 16 Jun 1992, *Felger 92-610*. Tinaja Altas Mts, 26 Oct 2004, *Felger 04-88*. †Tinajas Altas, leaves, involucres, achenes, 4010 to 15,680 ybp (13 samples).

Figure 28. *Brickellia atractyloides* var. *atractyloides*. Sedona, Coconino Co.: (A) 21 Apr 2001; (B) 3 Nov 2003. Photos by Max Licher (SEINet).

Brickellia californica (Torrey & A. Gray) A. Gray
California brickell-bush. Figure 29.

Shrubs to 1+ m tall, glandular pubescent. Leaves alternate, petioled, the blades often 2–8 cm long, ovate to deltate, the margins crenate to serrate. Inflorescences panicle-like, the flower heads elongated and somewhat cylindrical; phyllaries graduated, green and often purplish, the margins membranous; flowers pale yellow-green, 5.5–8 mm long. Achenes 2.5–3 mm long; pappus of white, barbellate bristles. Probably flowering at various seasons except winter, and especially after summer rains. The leaves are often thicker, larger, and more densely pubescent than those of *B. coulteri*, and not rigid like those of *B. atractyloides*.

Known from the flora area by a single record from the Ajo Mountains. It occurs east of the flora area in Pima County.

Southwestern United States northward to Idaho, and northwestern Mexico.

OP: Bull Pasture Trail, 2700 ft, 5 Nov 1977, *Bowers 929* (ORPI).

Figure 29. *Brickellia californica*. Sedona, Coconino Co.: (A) 9 Aug 2001; (B) 26 Sep 2002. Photos by Max Licher (SEINet).

Brickellia coulteri A. Gray var. **coulteri**
Triangle-leaf brickell-bush; *pachaba*. Figure 30.

Shrubs to 1 (1.5) m tall, with slender, brittle stems, pubescent and often gland-dotted, gradually drought deciduous. Herbage and outer phyllaries with glandular and crinkly white hairs. Leaves mostly opposite, petioled; blades often 3–6+ cm long, reduced above, relatively thin, ovate to triangular, green or purplish green, the base often hastate, the margins coarsely toothed. Flower heads in relatively few-flowered open panicles; heads 10+ mm long, cylindrical to narrowly campanulate. Phyllaries graduated, green to reddish purple, linear-attenuate, conspicuously striate-veined, the longer phyllaries 8–11 mm long. Flowers pale yellowish and purple. Achenes 2.5–4.5 mm long, blackish with short white hairs; pappus of barbellate bristles 5.5–7 mm long. Flowering at various seasons.

Often in washes and canyons in hills, bajadas, valley floors, as well as rocky slopes and mountains; often beneath desert trees such as *Olneya*. Widespread in Organ Pipe and the eastern part of Cabeza Prieta. It was in the Tinajas Altas Mountains from at least 5000 to 11,000 years ago, but there are no records for it there today.

Variety *coulteri* largely in the Sonoran Desert Region in Arizona and northwestern Mexico. Two other varieties in southwestern United States and Mexico.

OP: Bates Well, 15 Nov 1939, *Harbison 26143*. Rancho Bonito, 8 Dec 1939, *Harbison 26212* (SD). Arch Canyon, 28 Mar 1965, *Niles 542*. 4 mi N of Visitor Center, *Johnson 10 Nov 1983*. Bull Pasture, 10 Apr 2005, *Felger 05-225* (ARIZ, ASU).

CP: Base of Scarface Mt, 1650 ft, *Autenreith 20 Mar 1992* (ASC). Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-271*. Vicinity of Agua Dulce Pass, 13 Jun 1992, *Felger*, observation.
TA: †Tinajas Altas, twigs, involucres, 4490 & 10,950 ybp.

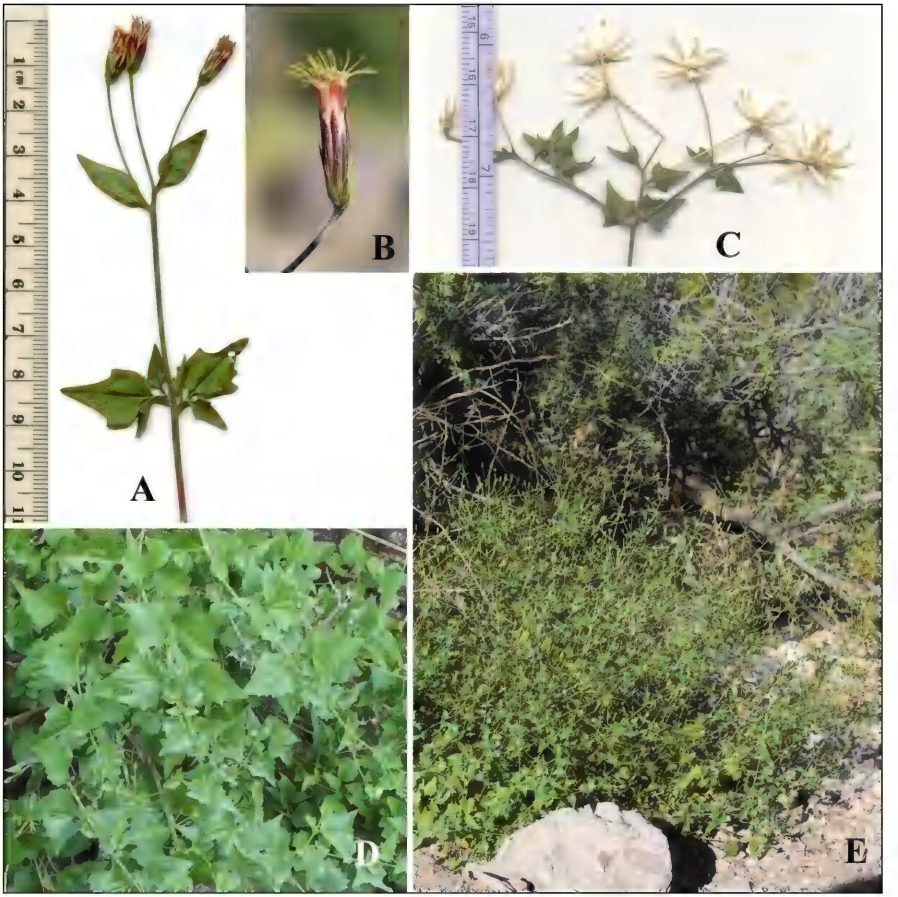

Figure 30. *Brickellia coulteri* var. *coulteri*. Alamo Canyon: (A) 22 Mar 2014; (B) 20 Oct 2013. (C) Victoria Mine, 22 Dec 2013. (D) Estes Canyon, 19 Sep 2014. (E) Chico Sunie Wash near Chico Sunie Village, 30 Oct 2014.

Brickellia frutescens A. Gray
Shrubby brickell-bush. Figure 31.

Small aromatic shrubs about 30 cm or more in height; gland-dotted. Leaves alternate, petioles very short, the blades oblong to spatulate, to 1.5 (2) cm long; margins entire. Inflorescences panicle-like, the heads cylindrical, 2 cm long, mostly greenish with small whitish flowers. Phyllaries graduated, often purple-tinged, the margins membranous. Florets purple-green. Achenes 3.5–4 mm long; pappus of white, barbellate bristles. Flowering at least March–May.

Ajo and Puerto Blanco mountains, especially at higher elevations on rocky slopes.

Distribution limited in southwestern Arizona; also southeastern California, southern Nevada, and Baja California.

OP: Canyon N of Alamo Canyon, 3000 ft, infrequent on rocky slope, 31 Mar 1948, *Darrow 3841*. Saddle between Boulder and Arch Canyon, 3800 ft, 3 May 1978, *Bowers 1289*. Bedrock tuff, ridgeline NNE slopes of Pinkley Peak, Puerto Blanco Mts, 31 Oct 2003, *Rutman 20031031-20*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-279*.

Figure 31. *Brickellia frutescens*. (A) Saddle between Boulder and Arch canyons, 21 Sep 2008. (B, C & D) Above Bull Pasture on trail to Mount Ajo, 10 Apr 2005.

†Brickellia sp.

OP: †Alamo Canyon, achenes, involucres, 14,500 to 32,000 ybp (3 samples).

Calycoseris

A genus of two species. Cichorieae.

††Calycoseris parryi A. Gray
Yellow tack-stem

Cool-season ephemerals present in the region more than nine millennia ago. The nearest present-day population occurs in the Sierra Pinacate in northwestern Sonora. Mostly a Mojave Desert species, also in the Sonoran Desert; southern and western Arizona, southeastern California, Nevada, and Utah. This species is distinguished from *C. wrightii* by its yellow rays, deeply grooved achenes and otherwise smooth achene surfaces.

OP: †Alamo Canyon, achenes, 9570 ybp.
TA: †Tinajas Altas, achenes, 9230 & 9900 ybp.

Calycoseris wrightii A. Gray
White tack-stem. Figure 32.

Figure 32. *Calycoseris wrightii*. (A) Ajo, 7 Mar 2015. Sonoyta Valley, S of Diablo Mts on Ajo Mountain Drive: (B) Stalked glands on peduncle, 5 Mar 2005; (C) 29 Feb 2008.

Spring ephemerals with milky sap and conspicuous tack-shaped glandular hairs. Leaves pinnately parted into narrow segments, the early leaves in a basal rosette, 3–10 cm long and often withering by flowering time, the stem leaves alternate and reduced upwards. Flowers nodding in bud, the florets ligulate (ray-like), the rays 10–20+ mm long, white with reddish streaks on the lower surfaces. Achenes 7 mm long, narrowed above into a neck or beak. Pappus bristles white, thread-like, readily deciduous.

Widely scattered across the region on sandy and gravelly, or gravelly-rocky, soils of floodplains, valley plains, dunes, bajadas, canyons, and mountains; not recorded for the westernmost part of Cabeza Prieta although recorded along Coyote Wash in the Tinajas Altas Region.

Southeastern California eastward across most of northern Sonora and Arizona to western Texas, and northward to Nevada and Utah.

OP: W base of Ajo Mts, 14 Mar 1941, *Benson 10657*. Sonoyta Hills, 25 Mar 1944, *Clark 11464* (ORPI). Near Dripping Springs, 16 Apr 1952, *Parker 7926*. Wash 2 mi W of Hwy 85 on 2-way Puerto Blanco Drive, 11 Apr 1978, *Bowers 1212*. Upstream from Bates Well, 11 Mar 2003, *Felger 03-287*.
CP: Near Charlie Bell Pass, 9 Apr 1993, *Felger 93-340*. Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-341*. 3 mi N of Tule Well, 11 Apr 1993, *Felger 93-446*.
TA: Coyote Water, 21 Feb 2005, *Felger 05-145*.

***Carthamus**

Native to the Mediterranean Region; 14 species. Cynareae.

****Carthamus tinctorius** Linnaeus

Safflower; *cártamo*. Figure 33.

Spring ephemerals in the flora area, glabrous, the stems stout and whitish. Leaves alternate, firm, the margins with spine-tipped teeth or entire. Heads thistle-like, 4–5 cm across, with large, bright yellow-orange disk florets. Achenes 7–7.5 mm long, white and plump; pappus none.

Occasional along roadsides and in disturbed habitats at the southern margin of Organ Pipe; not reproducing. The seeds are from harvested plants on trucks plying nearby Mexico Hwy 2. Safflower is a common oil-seed crop in Sonora.

Native to the Old World.

OP: Quitobaquito, 10 May 1979, *Bowers 1717* (ORPI).

Figure 33. *Carthamus tinctorius*. (A) Buckeye, Maricopa Co., 7 Jun 1975, *Engard 544* (DES). (B) Sedona, Coconino Co., 26 Jun 2001, photo by Max Licher (SEINet).

***Centaurea**

Native to Eurasia and northern Africa; 500 species. Cynareae.

***Centaurea melitensis** Linnaeus

Malta star thistle. Figure 34.

Thistle-like ephemerals, often 50–60 cm tall, or to 1 m or more when well watered and in partial shade. Herbage and phyllaries glandular and grayish with tangled woolly hairs at least when young. Lower leaves in a rosette, pinnatifid, 5–15+ cm long, the stem leaves smaller and with decurrent bases forming narrow wings on the stems. Phyllaries with a stout, straw-colored terminal spine and 2 or 3 pairs of smaller, lateral spines. Flower heads 1.5–2+ × 2.2–2.8 cm including phyllary spines. Flowers bright yellow, with disk florets but the marginal ones often ray-like and sterile; spring and early summer. The first flower heads develop in the rosette stage in early spring before the stems develop. Achenes ca. 2.5 mm long, minutely pubescent; pappus of numerous firm, white bristles.

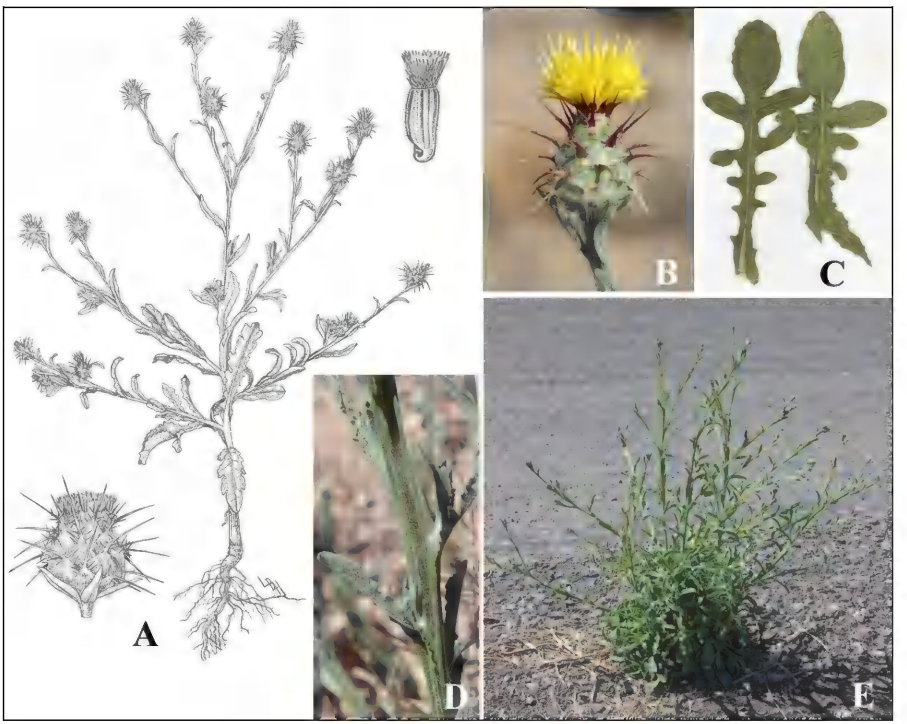

Figure 34. *Centaurea melitensis*. (A) By Lucretia Breazeale Hamilton. Near Ajo Way and Sandario Road, Tucson: (B, D & E) 16 Apr 2014; (C) 11 Apr 2010.

Known from two localities in the flora area where it is locally well established but apparently not spreading. Since the 1990s there has been an active program to eradicate it in Organ Pipe, but it will probably take a number of years to deplete the seed bank.

Scattered in mostly disturbed habitats across the Sonoran Desert. Widespread and weedy in the Americas; native to southern Europe and North Africa.

OP: Quitobaquito, old irrigation ditch below the pond, locally common, 19 Jun 1989, *Felger 89-251*.
CP: Jose Juan Tank, beneath mesquites (dead plants from previous spring), 14 Sep 1992, *Felger 92-716*.

Chaenactis

Spring ephemerals. Leaves alternate, pinnatisect with linear segments. Flower heads of white or pink disk florets, but the marginal florets often enlarged and appearing intermediate between disk and ray florets. Achenes club-shaped; pappus of fringed scales.

North America including Mexico; 18 species. Heliantheae, Chaenactidinae.

1. Stems with short white hairs, not cobwebby; phyllaries tips slender and elongated; heads with stout receptacle bristles among the florets; pappus scales 1–3 mm long..... **Chaenactis carphoclinia**
1. Herbage with cobweb-like woolly hairs; phyllary tips blunt; receptacle bristles none; pappus scales 3.5–6.5 mm long..... **Chaenactis stevioides**

Chaenactis carphoclinia A. Gray var. **carphoclinia**
Pebble pincushion. Figure 35.

Stems to about 25 cm tall, wiry, zigzag, solitary or with several or more branches above. Herbage with short white hairs, sometimes scarcely white woolly; herbage and phyllaries minutely glandular pubescent, or the leaves sometimes only sparsely glandular. Leaves pinnatisect with linear-filiform segments, the larger leaves 3–7 cm long, quickly drought deciduous. Heads rounded, 10–14 mm long; flowers white or pink. Phyllaries 6–10 mm long, extending into a slender, attenuate, bristle-like tip. Receptacle bristles interspersed among the florets. Achenes 3–4 mm long, columnar, blackish; pappus of 4 (5) scales.

Sandy flats, washes, desert pavements, rocky flats, and rocky slopes; often seasonally abundant and widespread, especially in sparsely vegetated places. It has been in Alamos Canyon for more than 1200 years.

Northwestern Sonora and Baja California to Utah and Nevada.

OP: Sonoyta Hills, *Clark 11473* (ORPI). 10 mi N of junction of Bates Well Rd and Puerto Blanco Drive, 30 Mar 1978, *Bowers 1118*. ¾ mi W of Bates Well, 23 Feb 2003, *Rutman 2003-186* (ORPI). Santa Rosa Mts, 12 Mar 2003, *Felger 03-352*. †Alamo Canyon, achene slender, 4.7 mm long, blackish, appressed white hairs, with four frayed pappus scales probably originally entire, the longest one 2.5 mm, 1150 ybp.
CP: Davidson Canyon, Agua Dulce Mts, 8 Apr 1979, *Lehto L23606* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3942*. Las Playas, 10 Apr 1993, *Felger 93-383*. Pinta Sands, 11 Apr 1993, *Felger 93-403*.
TA: Tinajas Altas, *Van Devender 26 Mar 1983*.

Figure 35. *Chaenactis carphoclinia* var. *carphoclinia*. Aguajita Wash at South Puerto Blanco Drive, 15 Mar 2015.

Chaenactis stevioides Hooker & Arnott
Desert pincushion. Figure 36.

Plants often 15–35 cm tall, moderately to densely and minutely glandular pubescent, the herbage, especially when young, sparsely to moderately white-woolly. Leaves pinnatisect with linear segments, the larger leaves 3–10 cm long, quickly drought deciduous. Flower heads 14–17 mm long, rounded, white or cream, the corollas pink in bud. Phyllaries 5–9 mm long, the tips blunt. Achenes 5.5–6 mm long, columnar, blackish; pappus of mostly 4 scales. The plants are generally more robust than those of *C. carphoclinia*. Flowering February into April.

Mostly on sandy flats and silty soils of valley bottoms, also on dunes and rocky slopes. It has been in the region for at least 9950 years.

Southwestern United States to Oregon and Colorado, and Baja California, Baja California Sur, and northern Sonora.

OP: Alamo Canyon: *Nichol 14 Mar 1939*; 5 Apr 1978, *Bowers 1197*. E of Quitobaquito, 25 Mar 1944, *Clark 11495* (ORPI). Dripping Springs, Puerto Blanco Mts, 12 Apr 1978, *Bowers 1255*. Growler Canyon, 30 Mar 1979, *Bowers 1598*. NE of Bates Mts, 23 Mar 2003, *Rutman 2003-403* (ORPI). Trail above Bull Pasture, 3220 ft, 10 Apr 2005, *Felger*, observation. †Alamo Canyon, two achenes, slender, 5.5 mm long, blackish, appressed white hairs, with four frayed pappus scales 4 mm long, linear-oblong, probably originally entire, 8130 ybp.

CP: 7 mi from Papago Well, 14 Mar 1937, *Harbison 17001* (SD). O'Neill Hills (Simmons 1966). San Cristobal Wash, 20 Mar 1992, *Telewski 4*. Growler Wash, 10 Apr 1993, *Felger 93-369*. Pinta Sands, 11 Apr 1993, *Felger 93-402*.

TA: W side of Tinajas Altas Pass, *Lindquist 26 Mar 1983*. †Tinajas Altas, achenes, 9900 ybp.

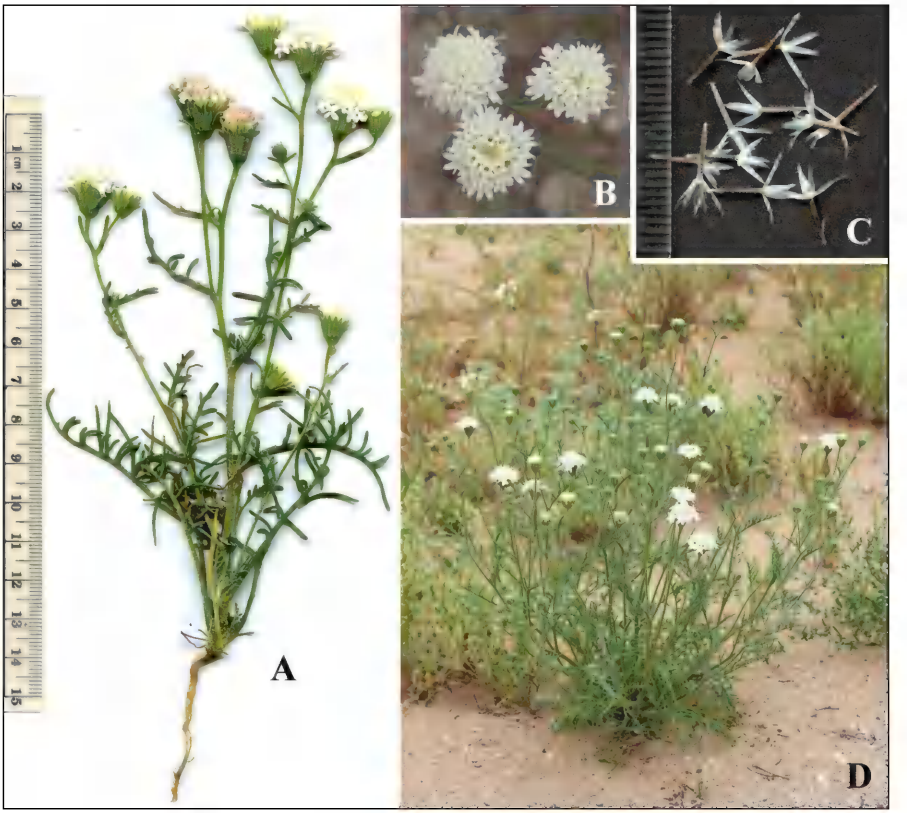

Figure 36. *Chaenactis stevioides*. (A) Ajo, 23 Mar 2015. (B) Upper Sonoyta Valley, southern part of Ajo Mountain Drive, 2 Mar 2008. (C) Hwy 86, 11 mi E of Why, 5 Apr 2015. (D) Large wash crossing Hwy 85 near mile marker 28, 18 Mar 2015.

Cirsium – Thistle

North America, Eurasia, and north Africa; 200 species. Cynareae.

Cirsium neomexicanum A Gray
New Mexico thistle; *cardo*; gewel. Figure 37.

Prickly thistles to about 1.7 m tall, with a stout, pithy, usually solitary main stem and sparsely branched above. Apparently ephemerals or annuals, or perhaps biennials (generally biennial herbs elsewhere). Beginning as rosette plants during the cool season and flowering in late spring. Rosette leaves to 30 cm long, pinnatifid and coarsely toothed and spiny; stem leaves with decurrent spiny bases forming wings on the stem. Flowers heads about 6+ cm long, the involucre globose, about 2–3 cm long, with spiny phyllaries, the flowers discoid, pale lavender. Achenes with plumose pappus bristles.

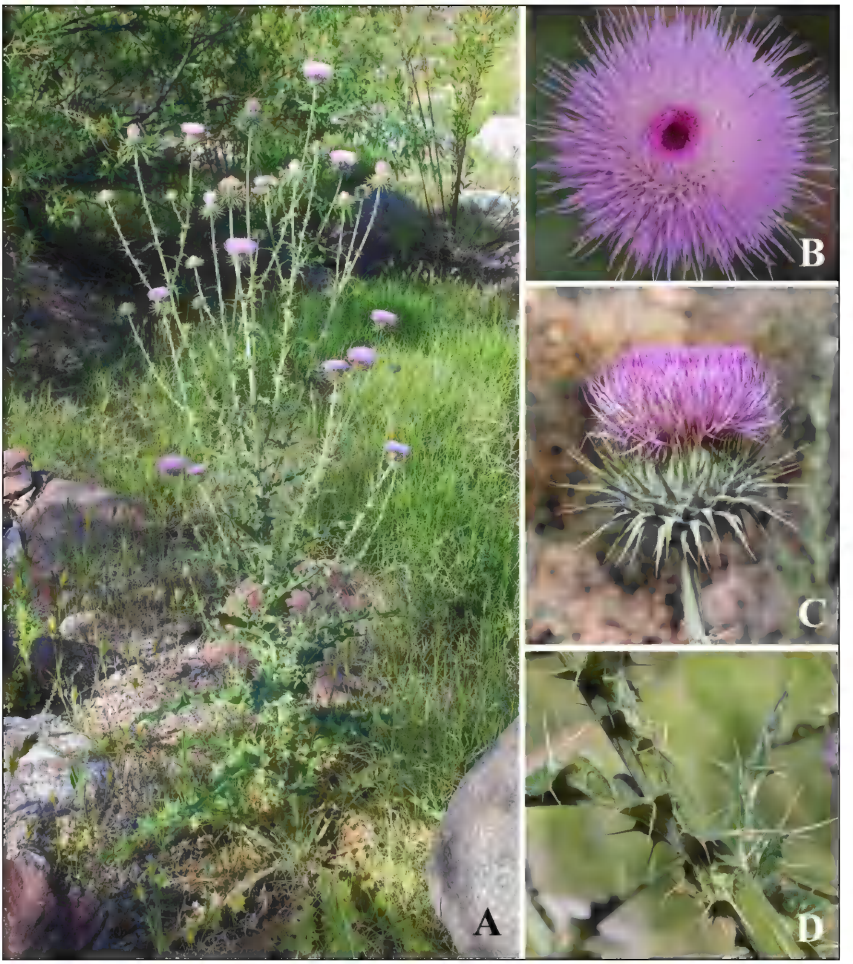

Figure 37. *Cirsium neomexicanum*. Alamo Canyon: (A) 16 Feb 2005; (D) 4 Apr 2015. Bull Pasture: (B) 7 Mar 2014; (C) 18 Mar 2005.

Ajo Mountains, especially at middle to higher elevations; common in Alamo Canyon and the Bull Pasture area. An unidentified thistle, perhaps this species, grew in the Ajo Mountains from 1200 to 20,500 years ago.

Southwestern United States and northwestern Mexico, and entering the Sonoran Desert only at its margins.

OP: Alamo Canyon, *Nichol 4 May 1939*. Canyon N of Alamo Canyon, 3000–3800 ft, *Gould 31 Mar 1948*. *Cirsium* cf. *neomexicanum*: †Alamo Canyon, phyllaries, achenes, 1150 to 29,110 ybp (5 samples). †Montezuma's Head, phyllaries, 20,490 ybp.

Diaperia

Southern United States and northern Mexico; 3 species. Gnaphalieae.

Diaperia verna (Rafinesque) Morefield var. **verna**

[*Evax multicaulis* de Candolle. *E. verna* Rafinesque. *Filago verna* (Rafinesque) Shinners var. *verna*]

Spring pygmy cudweed, rabbit tobacco. Figure 38.

Diminutive, white-woolly spring ephemerals mostly less than 10 cm tall. Leaves alternate, sessile, to about 10 mm long, mostly oblanceolate, and entire. Flower heads rounded, 2–3 mm wide, white-woolly. Achenes 0.7–0.9 mm long; pappus none. Unless closely examined the plants might be confused with other small gnaphalids (*Gamochaeta, Logfia*, and *Stylocline*)—the absence of a pappus is diagnostic.

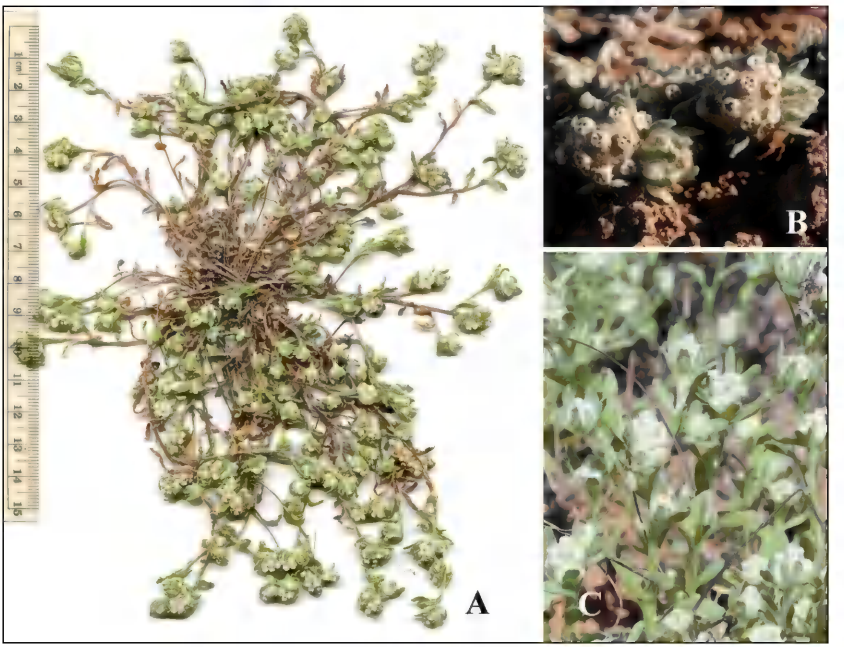

Figure 38. *Diaperia verna* var. *verna*. (A & C) Kuakatch Wash near N boundary of Organ Pipe, 9 Mar 2015. (B) NW of Carlsbad, Eddy Co., NM, 14 Apr 2007, photo by Patrick Alexander.

Southern United States from Arizona eastward, and northern Mexico; another variety occurs in Texas and Alabama.

OP: Flat near Kuakatch Wash, W of powerline, 28 Feb 2003, *Rutman 2003-195* (ORPI). Cuerda de Leña Wash near N boundary, 23 Mar 2003, *Rutman 2003-391*. Wash E of Dos Lomitas, 31 Mar 2003, *Rutman 2003-438*. Floodplain near N end of Pozo Nuevo Hills, 11 Apr 2003, *Rutman 2003-452* (ORPI).

CP: San Cristobal Wash, 3.2 mi WSW of boundary of Game Range, 1050 ft, wash, mesquite, *Larrea*, 11 Apr 1978, *Reeves 6827* (ASU, det. James D. Morefield 1992, mixed collection with *Filago arizonica*). San Cristobal Wash, 11 Apr 1992, *Steinmann 167*.

Dicoria

Dunes in northwestern Mexico and southwestern United States; 5 species. Heliantheae, Ambrosiinae.

Dicoria canescens A. Gray subsp. **canescens**
Bugseed. Figure 39.

Figure 39. *Dicorea canescens*. (A) Drawing by Francis Runyan. (B & C) Gran Desierto, near Mex Hwy 2, 5 Mar 2014. (D) Dunes S of Sierra Blanca, Sonora, 18 Feb 2015.

Robust annuals with coarse white hairs, generally growing with cool-season rains, flowering in summer and fall. Herbage gray-green with coarse white hairs; young plants have narrow leaves and the adult plants have broader and shorter leaves. Lower leaves opposite, upper ones alternate; most leaves 3.5–6 cm long, broadly ovate to sub-orbicular and shallowly toothed to nearly entire. Heads of disk florets only; flowers inconspicuous, wind pollinated, the staminate florets with a small corolla, the pistillate florets lacking a corolla. Phyllaries dimorphic; the outer phyllaries small and

reflexed, the inner ones much larger, convex, and loosely enclosing the achenes in an involucre resembling a paper lantern. Achenes 4–5.5 mm long, flat with intricately sculptured margins, seemingly well adapted to wind dispersal; pappus none.

Common on the Mohawk Dunes, near Yuma, and near the flora area in the Gran Desierto of northwestern Sonora. Not recorded from the flora area but possibly occurring west of Tinajas Altas and on dunes in Cabeza Prieta.

Often the most abundant plant on shifting dunes in northwestern Sonora and southwestern Arizona. Northwestern Sonora, northeastern Baja California, western Arizona, southeastern California, southern Nevada, southwestern Utah. Two subspecies and several varieties of questionable significance in the northern part of the range.

Dieteria

Western North America and northern Mexico; 3 species. A genus segregated from *Machaeranthera*. Astereae.

Dieteria asteroides Torrey var. **glandulosa** (B.L. Turner) D.R. Morgan & R.L. Hartman
[*Machaeranthera asteroides* (Torrey) Greene var. *glandulosa* B.L. Turner]
Fall tansy-aster. Figure 40.

Ephemerals or short-lived perennials, to 80 cm tall. Herbage and phyllaries with gland-tipped hairs. Leaves alternate, sessile, lanceolate to oblanceolate, 2–10 cm long, the margins toothed or smaller leaves often entire. Flower heads hemispheric, the involucres 1–1.5 cm wide, the phyllaries graduated. Disk florets yellow, the rays violet, 1–2 cm long, becoming inrolled. Ray and disk achenes with a pappus of numerous slender, tan bristles 4.5–9 mm long; disk achenes 4.5–5 mm long.

Ajo Mountains to peak elevation.

Variety *glandulosa* occurs in southern Arizona to Utah, New Mexico, and Sonora. Two other varieties in northwestern Mexico and southwestern United States.

OP: Alamo Canyon, 18 Dec 1945, *Goodding & Supernaugh 485-45.* Arch Canyon, *Wirt 30 Sep 1989* (ORPI). Bull Pasture Trail: *Cummins 11 Oct 1976*; 5 Nov 1977, *Bowers 955*; 25 Sept 2013, *Rutman 20130925-9*. Puerto Blanco Drive, *Bowers 1756* (ORPI).

Dyssodia concinna, see **Thymophylla concinna**

Dyssodia pentachaeta, see **Thymophylla pentachaeta**

Dyssodia porophylloides, see **Adenophyllum porophylloides**

Eclipta

Native in temperate to tropical regions of the New World; 4 species. Heliantheae, Ecliptinae.

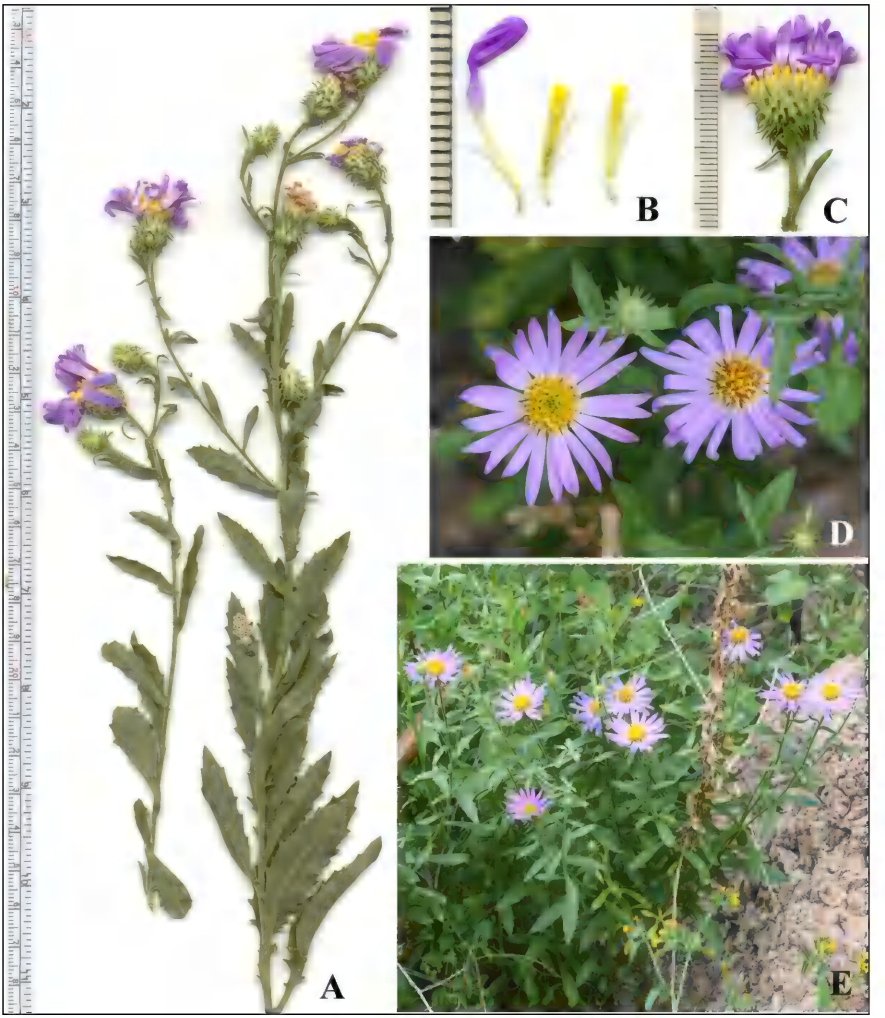

Figure 40. *Dieteria asteroides* var. *glandulosa*. Trail to Bull Pasture: (A) 21 Sep 2008; (B & C) 8 Sep 2014. (D & E) Bull Pasture, 18 Mar 2005.

Eclipta prostrata (Linnaeus) Linnaeus
[*E. alba* (Linnaeus) Hasskarl. *E. erecta* Linnaeus]
False daisy; *chile de agua, hierba del tajo*. Figure 41.

Delicate ephemerals, spring to winter, flowering more or less continuously during warm weather and winter dormant, or the plants killed by the first frost. Leaves 5–14 cm long, sessile, mostly narrowly elliptic; margins with few, small teeth. Flower heads 4–7 mm wide, the rays white,

numerous, and minute, the disk florets yellow. Achenes 2.5–3 mm long, 3- or 4-angled, wrinkled and warty; pappus none or rudimentary.

Rooted in water along ditches at Quitobaquito and nearby in wetlands in the Sonoyta region.

Widespread in the Americas and widely naturalized in the Old World.

OP: Quitobaquito: Growing along ditches, *Drouet 8 Oct 1960*; Ditches leading from springs to pond, 27 Mar 1966, *Niles 724* (ARIZ, ASU).

Figure 41. *Eclipta prostrata*. NE of Moctezuma, SW base of Sierra la Madera, Sonora, 28 Jul 2011, photos by M. Valenzuela-Yánez (MABA in SEINet).

Encelia

Small shrubs, usually pubescent. Leaves alternate. Ray florets sterile or absent; disk florets yellow or brown, and bisexual. Disk florets and achenes enclosed by chaffy bracts. Achenes flat, the margins narrow, white, and long haired; pappus none or of 2 slender awns.

Southwestern United States, Mexico, and South America; 14 species. Heliantheae, Ecliptinae.

1. Leaves and stem tips white-woolly; leaves mostly 3–10 cm long, 1.5–3.5 cm wide; heads usually several or more in broad panicles, the peduncles essentially glabrous; rays well developed. ..... **Encelia farinosa**
1. Leaves and stems rough haired (scabrous); leaves mostly 2–3 cm long, 0.35–0.6 (1) cm wide; heads mostly solitary, the peduncles hairy; rays none or sometime present but reduced. ..... **Encelia frutescens**

Encelia farinosa A. Gray ex Torrey
[*E. farinosa* forma *phenicodonta* S.F. Blake. *E. farinosa* var. *phenicodonta* (S.F. Blake) I.M. Johnston]
Brittlebush; *incienso*, *hierba del bazo, rama blanca*; tohaves. Figure 42.

Shrubs, mostly not long-lived, 0.5–1.6 m tall (excluding inflorescences), with a dense, rounded or hemispherical crown, often aromatic. Leaves drought deciduous or dry leaves semi-persistent, and highly variable with soil moisture, 3–10 cm long including petiole; blades 1.4–3.6 cm wide, mostly ovate, entire or nearly so, often white-woolly (conspicuously greener and thinner when

produced during wet periods, whiter and thicker when produced during dry times). Flowering branches of slender, usually few-branched panicles (8) 20–30 cm tall, usually raised well above the foliage; peduncles glabrate or sparsely woolly, especially near the flower heads. Rays bright yellow, 12–18 mm long, the disk florets yellow or maroon-brown. Achenes 3.5–5 mm long, flat, blackish, the body outlined with long white hairs; pappus none; the flower heads turn downward near the end of anthesis and the seeds ripen in that down-curved position, dumping out the achenes. Massive displays of showy daisy-like flowers during favorable seasons, especially in February and March.

Figure 42. *Encelia farinosa*. (A) By Lucretia Breazeale Hamilton. Estes Canyon: (B) 27 Feb 2014; (E) 18 Mar 2005. Organ Pipe headquarters area: (C) 7 Mar 2009; (D) 18 Jan 2009.

One of the most common shrubs in the region; in many habitats including all slope exposures and to most mountain summits, dry washes, and bajadas; generally not in open creosotebush flats and not on dunes. It has been in the area for more than 37,000 years.

The plants are frost sensitive and sometimes severely nipped by freezing weather; they are fast growing and can recover quickly from drought or freeze damage. Javelinas sometimes eat the flowers. Both color forms, those with brown centers, which have been called var. *phenicodonta*, and ones with yellow centers, occur in southwestern Arizona and northwestern Sonora, often intermixed.

Desert and semi-arid regions in northwestern Mexico and southwestern United States.

The yellowish resin that oozes from wounds in the stems becomes hard when dry, plastic when heated, and was used as glue or sealant for hafting arrows and waterproofing vessels (Felger & Moser 1985; Uphof 1968). Hia-Ced O'odham used it as chewing gum when soft and as bow resin for fiddles when hard (Philip Salcido in Felger et al. 1992). "We'd chew and chew it. . . . That's what the Indians used for gum" (Betty Melvin in Zepeda 1985: 76). The resin was also used for medicinal purposes and burned as incense (Felger & Moser 1985; Uphof 1968).

OP: Alamo Canyon, *Nichol 4 May 1939*. Victoria Pass near Burnham's Mine, 8 Apr 1941, *McDougall 55*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1130*. Arch Canyon, 2550–2900 ft, 11 Mar 1983, *Daniel 2587* (ASU). †Alamo Canyon, leaves and mostly achenes, 1150 to 32,000 ybp (seven samples). †Montezuma's Head, achenes, 20,490 ybp. †Puerto Blanco Mts, on ridge, achenes, modern (30) to 10,540 ybp (20 samples).

CP: N side of Tule Mts, 2 Feb 1992, *Felger*, observation. ¾ mi NE of Agua Dulce Pass, *Vetault 17 Mar 1988*. Papago Well, 277 m, 11 Apr 1978, *Lehto L22486* (ASU). El Camino Diablo, 10.3 mi WSW of Papago Well, 12 Mar 1983, *Daniel 2677* (ASU).

TA: Tinajas Altas, 5 Dec 1935, *Goodding 2204*. 2.5 mi SE of Tinajas Altas, 22 Nov 2008, *Felger 08-200* (ARIZ, BRIT, DES). †Butler Mts, twigs, leaves, achenes, 740 to 11,250 ybp (7 samples). †Tinajas Altas, leaf fragments, achenes, 1230 to 18,700 (19 samples), & >37,000 ybp.

Encelia farinosa × E. frutescens

Several isolated plants of this putative hybrid have been found in Organ Pipe and the Tinajas Altas Region. The leaves are intermediate in shape from the presumed parent species, and the flower heads bear bright yellow rays.

OP: 2 mi by road WSW of Bates Well, 30 Mar 1978, *Bowers 1131*.
TA: Camino del Diablo, E of Raven Butte, 29 Nov 2001, *Felger 01-585* (ARIZ, ASU).

Encelia frutescens (A. Gray) A. Gray

Button encelia, rayless encelia. Figure 43.

Rounded shrubs often 0.9–1.5 m tall. Stems brittle and slender, densely hairy at first, glabrate and whitish with age. Herbage scabrous, the hairs white and often expanded basally. Leaves 17–32 × 3.5–6 (12) mm, sparsely hairy, petioled, the blades green, narrowly ovate to oblong. Flower heads solitary, 1.3–1.6 cm wide, rounded, with bright yellow disk florets, and without rays or occasionally with reduced rays. Achenes 7–10 mm long; pappus none. Flowering in warmer months.

Mostly on sandy loam or sandy soil of valley bottoms, margins of washes, and especially common along roadsides in sandy soil in the Pinta Sands, the western margin of Cabeza Prieta, and the Lechuguilla Valley.

Southeastern California, southwestern Arizona, northeastern Baja California, and northwestern Sonora.

Two varieties are often recognized. Variety *glandulosa* C. Clark occurs in northeastern Baja California. *Encelia frutescens* var. *virginensis* (A. Nelson) S.F. Blake is recognized as *E. virginensis* A. Nelson.

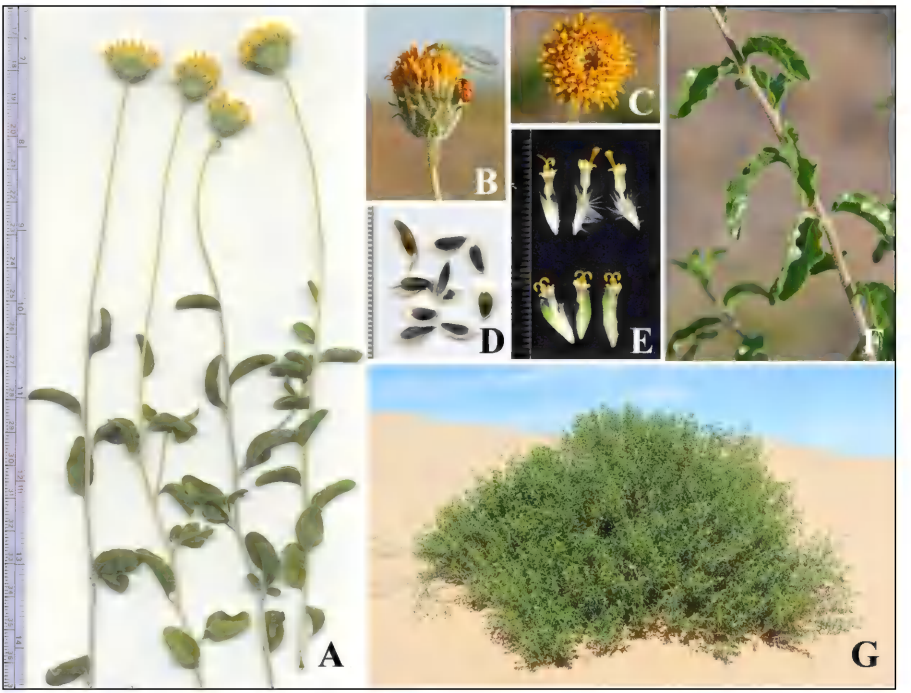

Figure 43. *Encelia frutescens*. Why: (A) 6 Oct 2013; (B & F) 14 Apr 2005; (C) 8 Apr 2005; (D) 12 Sep 2014. (E) Midway Wash near Hwy 85, 18 Mar 2015. (G) Gran Desierto, Mex Hwy 2, W of Pinacate lava field, Sonora, 5 Mar 2014.

OP: Quitobaquito, 25 Mar 1944, *Clark 11477* (ORPI). 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1130*. Armenta Road, W of Hwy 85, *Rutman 16 Aug 2001* (ORPI).

CP: S4, T14S, R13W [NW of Pinacate Lava], 7 Apr 1979, *Lehto L23586* (ASU). Monreal Well, *Edwards 20 May 1978* (ASU). Pinta Sands at W side of Pinacate lava, along Camino del Diablo, 22 Mar 1992, *Telewski 106*.

TA: Coyote Water, 25 Oct 2004, *Felger 04-65*. Lechuguilla Valley along Camino del Diablo, immediately W of Cabeza Prieta, 28 Mar 2010, *Felger 10-159*.

Ericameria

Woody-based small shrubs, glabrous and resinous with dot-like glands (punctate). Flower heads with disk florets or both ray and disk florets. Achenes ribbed, with many minutely barbed pappus bristles.

Western North America and northern Mexico; 36 species. Astereae.

1. Leaves broadly spatulate (widest toward the tip), more than 3 mm wide; pappus about as long as the corolla..... **Ericameria cuneata**
1. Leaves linear, less than 2 mm wide; pappus shorter than the corolla..... **Ericameria laricifolia**

Ericameria cuneata (A. Gray) McClatchie var. **spathulata** (A. Gray) H.M. Hall
[*Haplopappus cuneatus* A. Gray var. *spathulata* (A. Gray) S.F. Blake]
Wedge-leaf goldenbush. Figure 44.

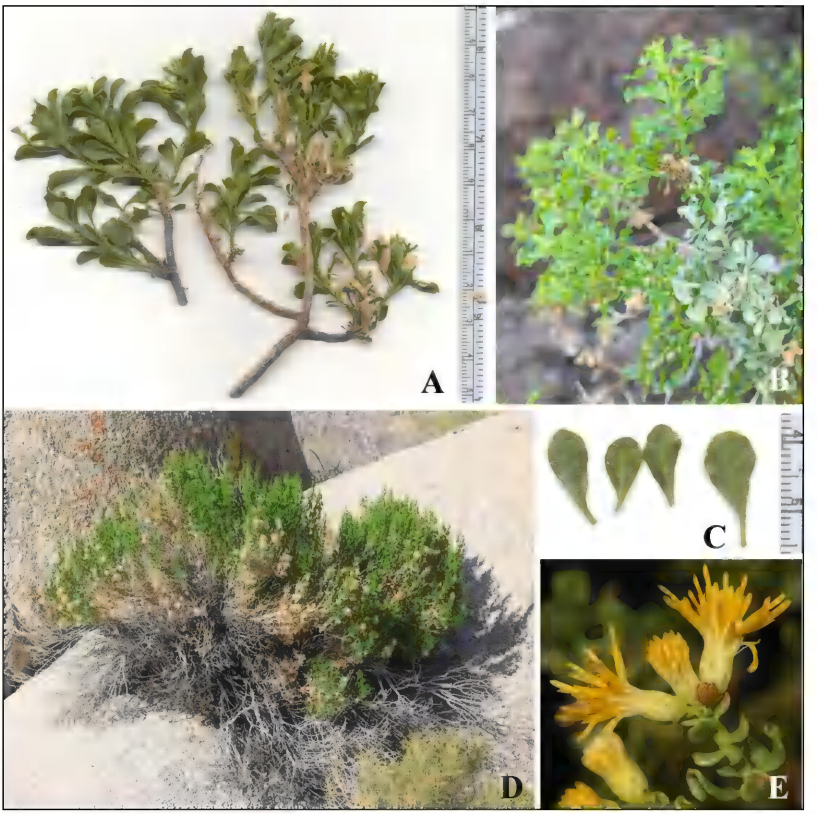

Figure 44. *Ericameria cuneata* var. *spathulata*. (A & C) Upper Estes Canyon, 21 Sep 2008. (B) Alamo Canyon, 12 Mar 2005. (D) Indian Cove, Joshua Tree National Park, CA, 30 Apr 2012. (E) White Mts, base of E side, Deep Springs Valley, Mono Co., CA, 15 Sep 2012, photo by Steve Matson (CalPhotos).

Dwarf shrubs to 80 (100) cm tall. Herbage and phyllaries gland-dotted; leaves petioled, the blades broadly spatulate, often 1–2.5 cm long. Flower heads crowded in short, terminal clusters, with bright yellow disk florets. Achenes 3–3.5 mm long, sub-cylindrical, brown, and with white hairs.

Ajo Mountains, mostly at higher elevations; often growing from crevices in cliffs and rock faces. Also isolated at higher elevation on a north-facing slope in the Growler Mountains in Cabeza

Prieta. It was more widespread during the late Wisconsin, and ranged across the flora area from about 9000 to more than 37,000 years ago.

Southern Nevada, southeastern California, southwestern Arizona and nearby Baja California and Sonora; entering the margins of the deserts.

OP: Estes Canyon, 3800 ft, *Henry 6 Nov 1977* (ORPI). Arch Canyon: 3000 ft, 3 Nov 1981, *Phillips 81-477* (MNA); 900 m, 2 Dec 1990, *Felger 90-513*. †Alamo Canyon, leaves, 9570 to 32,000 ybp (4 samples). †Montezuma's Head, leaves, 13,500 to 21,840 ybp (4 samples).

CP: Growler Mts, 0.8 mi S and 0.4 mi E Growler Peak, UTM 3567958, 309536, N-facing slope, 24 Mar 2009, *Holm 20090324-5* (ARIZ 310588, 412608; specimens not located, August 2016).

TA: †Tinajas Altas, leaves, 8970 to 15,680 ybp (4 samples), & >37,000 ybp.

Ericameria laricifolia (A. Gray) Shinners
[*Haplopappus laricifolius* A. Gray]
Turpentine bush. Figure 45.

Shrubs to 1 m tall with dense, bright green, and conspicuously resinous foliage. Herbage gland-dotted. Leaves linear to narrowly oblanceolate, 1–2 cm long, 1–2 mm wide. Flower heads crowded in short, terminal clusters; flowers bright yellow, with disk and ray florets (or rays sometimes absent), flowering October and November. Achenes 3–3.5 mm long, narrowly obconic, brown, densely pubescent with whitish hairs.

Ajo Mountains, especially at higher elevations; canyons, rocky slopes, and cliffs. It seems to have been very common in the late Wisconsin, and ranged across the flora area from about 9000 to 18,700 years ago. It has been in the Ajo Mountains for at least 32,000 years.

Southeastern California (in the eastern, upland part of the Mojave Desert in the summer rain zone) to western Texas and adjacent Sonora and Chihuahua, mostly at elevations above the desert.

OP: Pitahaya Canyon, *Nichol 23 Feb 1939* (ORPI). Bull Pasture, *Bezy 25 Oct 1964*. Near top of Ajo Mts, *Dakan 25 Jan 1973* (ORPI). Alamo Canyon, 3 Dec 1977, *Bowers 969*. Near the Arch in Arch Canyon, rooted in bedrock outcrop on steep NE-facing slope, 26 Oct 2003, *Rutman 20031026-12*. †Alamo Canyon, twigs, leaves, 1150 to 32,000 ybp (6 samples). †Montezuma's Head, twigs, leaves, 13,500 to 21,840 ybp (3 samples). †Puerto Blanco Mts, on ridge, leaves, involucres, 14,120 ybp.

TA: †Butler Mts, twigs, leaves, involucres, 10,360 ybp (common in this sample). †Tinajas Altas, leaves, 8970 to 18,700 ybp (10 samples).

††**Ericameria teretifolia** (Durand & Hilgard) Jepson
[*Chrysothamnus teretifolius* (Durand & Hilgard) H.M. Hall]
Green rabbit-brush

Small shrubs with crowded, dark green, very slender, resinous leaves, and yellow disk flowers.

Green rabbit-brush was present in Organ Pipe more than 14,000 years ago and in the Tinajas Altas Mountains from 15,000 to more than 37,000 years ago.

The nearest present-day populations are in northwestern Arizona. Also southern California and southern Nevada; western edge of the Sonoran Desert, the Mojave Desert, and extending into pinyon-juniper vegetation.

OP: †Puerto Blanco Mts, on ridge, leaves, involucres, 14,120 ybp.

TA: †Tinajas Altas, leaves, involucres, 15,050 to 18,700 & >37,000 ybp (4 samples).

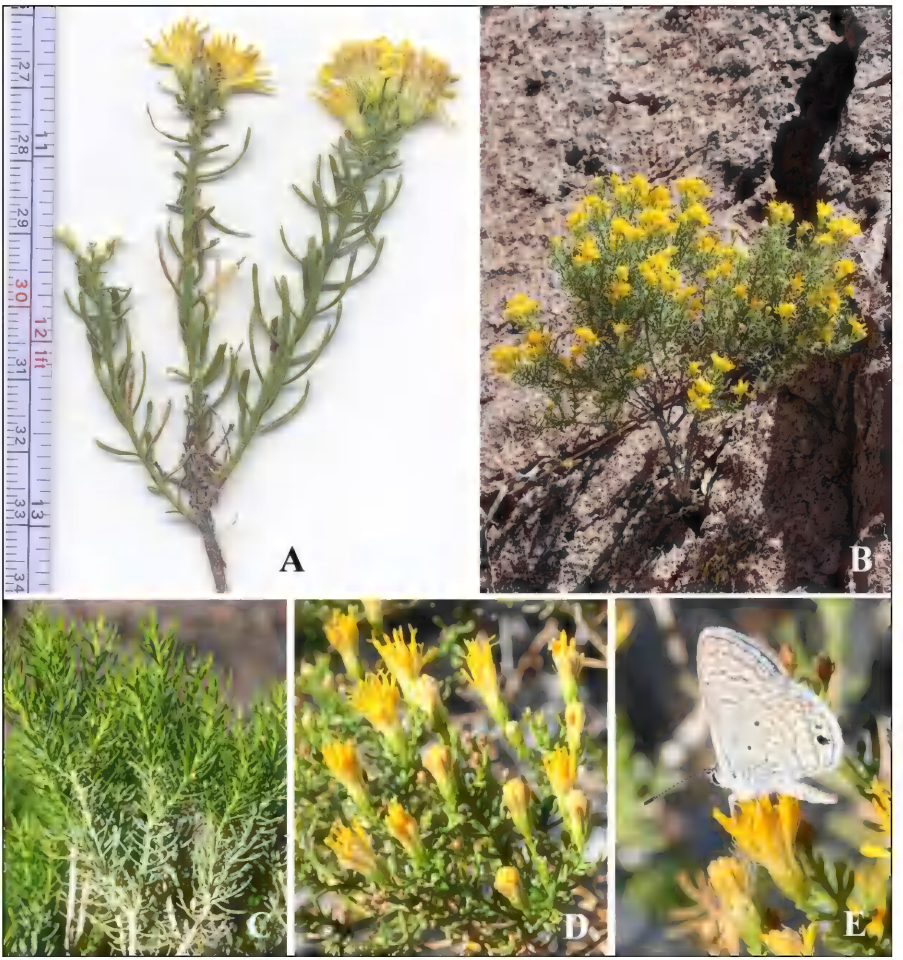

Figure 45. *Ericameria laricifolia*. (A & B) Alamo Canyon above first waterfall, 17 Oct 2013. Above Bull Pasture on trail to Mt Ajo: (C) 12 Mar 2005; (D) 22 Oct 2006; (E) Edward's Blue (*Hemiargus ceraunus*), 22 Oct 2006.

††**Ericameria** sp.
[*Chrysothamnus* sp.]

Shrubs. These Wisconsin-age samples have flower heads that look like one of the northern Arizona species that does not occur in the flora region today.

OP: †Alamo Canyon, involucres, 14,500 & 29,110 ybp. Montezuma's Head, involucres, 20,490 ybp.

Erigeron – Fleabane. Contributed in collaboration with Walter Fertig.

Ephemerals to short-lived perennial herbs. Leaves alternate. Flower heads usually with many ray and disk florets, the disk florets minute. Achenes with pappus of many slender and often fragile bristles.

Worldwide, mostly temperate regions; 390 species. Astereae.

1. Leaves linear; flower heads upright, to 5 mm wide; all corollas white..... **Erigeron canadensis**
1. Leaves obovate; flower heads nodding in bud, more than 10 mm wide, disk florets yellow, the rays pale lavender. ..... **Erigeron lobatus**

***Erigeron canadensis** Linnaeus
[*Conyza canadensis* (Linnaeus) Cronquist]
Horseweed; *cola de caballo, hierba del caballo*. Figure 46.

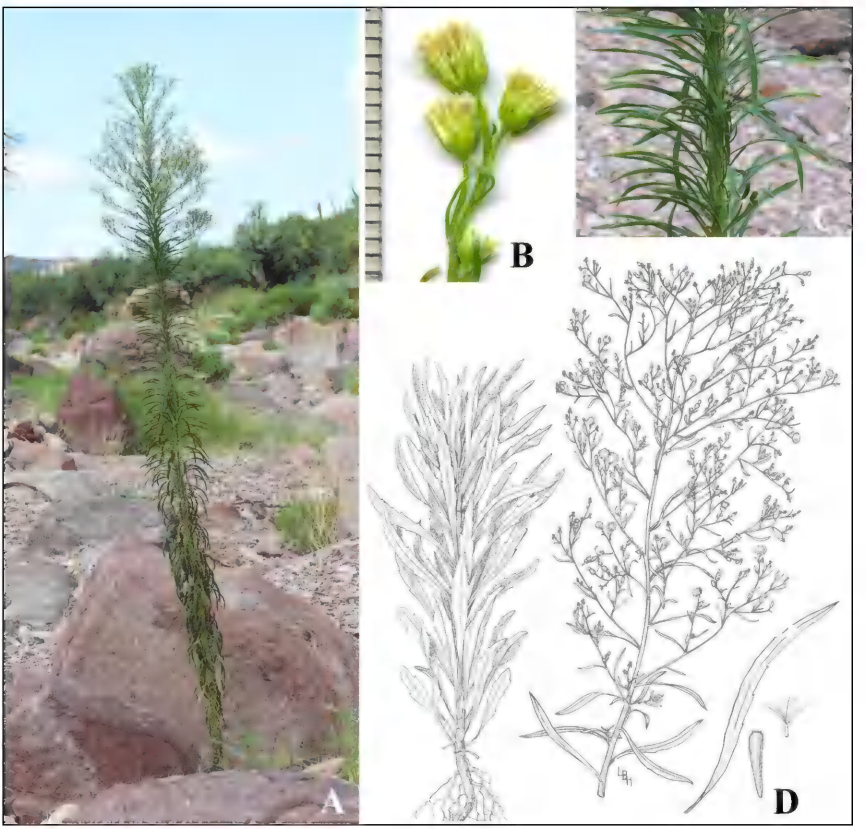

Figure 46. *Erigeron canadensis*. Alamo Canyon near Alamo Well: (A) 9 Sep 2013; (B) 3 Sep 2014; (C) 7 Sep 2013. (D) By Lucretia Breazeale Hamilton.

Weedy, slender, erect ephemerals to 1 (2+) m tall, mostly unbranched except the terminal flowering portion; growing and flowering during warmer months. Herbage sparsely pubescent, the leaves hispid with coarse white hairs mostly along leaf margins. Leaves narrowly lanceolate, larger ones often 3–8 cm × 2–6 mm, sessile but narrowed at base, the margins entire or with a few shallow teeth, and ciliate and strigose all around. Flower heads 2.5–4 mm wide, bearing numerous disk and disk-like (reduced rays) white florets; phyllaries graduated and glabrous. Achenes 1 mm long; pappus slightly more than twice as long as the achenes, minutely barbellate.

Sometimes locally common at charcos, sandy-silty soils at waterholes, and washes where water settles, especially along the Mexico border east of Lukeville, spreading from disturbed habitats and farmland in adjacent Sonora.

A worldwide weed, native to North America but apparently not native in the flora area.

OP: 0.5 mi E of Lukeville, 11 Nov 1987, *Felger 87-322*.
CP: Jose Juan Represo, 12 Jun 1992, *Felger 92-568*.

Erigeron lobatus A. Nelson
Spreading fleabane. Figure 47.

Winter-spring ephemerals and sometimes also in summer, and sometimes persisting as multi-season annuals; single to multiple-stemmed, 5–52 cm tall or long; taproot well developed (even on small plants). Stems slender and flexible. Leaves soft and pale green, obovate; the first leaves generally in a basal rosette; leaves often pinnately lobed, especially on better-watered plants, or entire or with a few coarse teeth, especially on drought-stressed plants; upper stem leaves markedly reduced. Stems, leaves, and phyllaries pubescent with larger, simple white hairs 0.5–1 (2) mm long and often curved upward, and these interspersed with minute stalked and sessile glands. Flower heads nodding in bud, mostly 1.7–2 cm wide including the rays when fully open. Phyllaries many, more or less in 2 whorls, mostly 4–4.5 mm long, the inner ones broader and with membranous margins. Rays 85–110, pale lavender. Disk florets yellow. Achenes 1.3 mm long, pappus of slender (capillary) bristles 2–2.5 mm long as well as shorter, broader, fringed bristles.

Widely scattered across the flora area, in many habitats and various substrates, often localized on clayish or fine-textured, poorly draining soils at waterholes and temporarily wet habitats including washes and playas, and also in canyons and on slopes, and sometimes from cracks in bedrock. The largest population probably occurs at Las Playas and is seen only during seasons of favorable rains.

Erigeron lobatus occurs in southeastern Californica, southern and western Arizona, southern Nevada, and northwestern Sonora eastward to the vicinity of Magdalena. It is usually distinguishable from the geographically more widespread *E. divergens* by leaves with rounded lobes, as well as the presence of both stalked glandular hairs and longer and spreading non-glandular hairs.

"*Erigeron lobatus* is characterized by persistent basal and proximal cauline leaves with rounded to acute lobes, vestiture of stipitate glands and sparse, spreading, hispido-pilose hairs, heads on relatively long, ebracteate peduncles, and broad, thin phyllaries. *Erigeron divergens* often is similar; its glandularity is not stipitate and its nonglandular hairs are shorter and denser" (Nesom 2006: 338). *Erigeron divergens* is widespread in Arizona but has not been found in the flora area. Specimens previously attributed to *E. divergens* Torrey & A. Gray within the flora area have been re-determined as *E. lobatus*.

Figure 47. *Erigeron lobatus*. Alamo Canyon: (A) 24 Mar 2008; (C) 12 Mar 2005; (D) 9 Sep 2013. (B) Bull Pasture, 5 Apr 2010.

OP: Cipriano Well, *Nichol 27 Apr 1939*. Alamo Canyon: *Nichol 4 May 1939*; 13 Dec 1939, *Harbison 26241* (SD); N fork, 11 Mar 1950, *Supernaugh 436*. Estes Canyon, 25 Feb 1978, *Bowers 1072*. Growler Canyon, 30 Mar 1979, *Bowers 1599*. Dripping Springs, 6 Mar 1988, *Pinkava 14353* (ASU, ORPI). Quitobaquito, 25 Apr 1990, *Felger 90-91*.

CP: Mohawk Valley, between Christmas Pass and N Refuge boundary, 13 Apr 1992, *Harlan & Steinmann 266*. San Cristobal Wash, 20 Mar 1992, *Harlan & Telewski 36*. Jose Juan Represo, 12 Jun 1992, *Felger 92-569-A*. Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-325*. Las Playas, 11 Jan 2002, *Felger 02-31*. Cabeza Prieta Tanks, 15 Jun 1992, *Felger*, observation.

TA: Coyote Water, 18 Mar 1998, *Felger 98-118*.

Eriophyllum

Western North America and Mexico; 13 species. Heliantheae, Baerinae.

Eriophyllum lanosum (A. Gray) A. Gray
[*Antheropeas lanosum* (A. Gray) Rydberg]
Woolly daisy. Figure 48.

Small spring ephemerals, conspicuously white-woolly. Stems slender, erect to spreading or decumbent, often 2–12 cm long. Leaves of seedlings and young shoots often opposite, otherwise alternate; leaves linear to narrowly oblanceolate, entire, the larger ones 7–15 mm long. Heads 5–8 mm wide, solitary on slender peduncles; phyllaries in one whorl, densely woolly, 5–6.5 mm long.

Rays 5–7 mm long, pistillate and fertile, white with red stripes below, the disk florets yellow, bisexual and fertile. Achenes 2.5 (3) mm long, slender, blackish with appressed white hairs; pappus of flattened outer scales and longer, awn-like inner bristles.

Figure 48. *Eriophyllum lanosum*. (A & B) Hwy 85, near N boundary of Organ Pipe, 14 Feb 2015. (C) Javelina Mtn, Sauceda Mts, 5 Mar 2005.

Widespread and often common in Organ Pipe and the eastern portion of Cabeza Prieta; valley bottoms, washes, and rocky slopes and mountains.

Southeastern California, southern Nevada, southern and western Arizona, southwestern New Mexico, southwestern Utah, northern Sonora, and both Baja California states.

OP: Puerto Blanco Mts, trail to Dripping Springs, 4 Apr 1973, *Holmgren 6653* (ASU). Arch Canyon trail, 11 Mar 1983, *Daniel 2592* (ASU). Armenta Road 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-268*. W side of Sierra Santa Rosa, along border, 12 Mar 2003, *Felger 03-367*. Hwy 85, 1 mi S of N boundary, 29 Mar 2003, *Harlan 03-6*.

CP: Growler Valley, *Phelps 18 Mar 1978* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3944*. Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-312*. Growler Wash, 10 Apr 1993, *Felger 93-370*.

Evax, see **Diaperia**

Gaillardia – Blanket flower

North America including Mexico, and South America; 15 species. Heliantheae, Gaillardinea.

Gaillardia arizonica A. Gray
[*G. arizonica* var. *pringlei* (Rydberg) S.F. Blake]
Arizona blanket-flower. Figure 49.

Spring ephemerals with sessile glands and white, often crinkled hairs to more than 2 mm long. Leaves basal, 3–10 cm long, or alternate, entire to toothed or pinnatifid. Heads showy, solitary at branch tips, 3.5–4 cm wide. Phyllaries separate, green and leafy, narrowly to sometimes broadly lanceolate, the outer (larger) phyllaries 6–14 mm long. Ray and disk florets bright yellow; rays 12–28 mm long, broad and cleft into 3 conspicuous terminal lobes. Achenes 2.5–3 mm long, obscured by dense, ascending hairs at first white, becoming golden brown; pappus of broad, membranous scales, the midrib sometimes extended into an awn.

Widely scattered in small, localized populations. Mostly along washes and arroyos in the eastern part of Cabeza Prieta, such as the San Cristobal Valley on loamy flats where water settles, and similarly on the muddy flats of Las Playas. Organ Pipe in fine soils such as on flats east of Growler Canyon in the Bates Mountains, the north-central part of the Monument, and the northeast bajada of the Puerto Blanco Mountains.

Northern Sonora, Arizona, Nevada, and southwestern Utah.

OP: Near N entrance of Organ Pipe, 24 Mar 1941, *McDougall 31*. Dripping Springs, 15 Apr 1951, *Parker 7924*. Growler Canyon, S of Bates Well, 19 Mar 1975, *Lehto L8304* (ASU). Cuerda de Leña, 23 Mar 2003, *Rutman 2003-392* (ORPI).

CP: 7 mi E of Papago Wells, 14 Mar 1937, *Harbison 16850* (SD). Jose Juan Tank, *Monson 24 Apr 1958* (CAB). S of Las Playas, 10 Apr 1978, *Lehto L22468*. Deer Hollow, N of Agua Dulce Mts, 20 Mar 1982, *Reichenbacher 923*. Charlie Bell Road at W branch of Daniels Arroyo, 10 Apr 1993, *Felger 93-345*. San Cristobal Wash, N boundary of Refuge, *Malusa 18 Apr 2001*.

Figure 49. *Gaillardia arizonica*. Pipeline Road NE of Ajo, 15 Mar 2008.

Gamochaeta

Native to the Western Hemisphere; 50 species. Gnaphalieae.

Gamochaeta stagnalis (I.M. Johnston) Anderberg
[*Gnaphalium stagnale* I.M. Johnston]
Desert cudweed, rosy everlasting. Figure 50.

Small spring ephemerals, to about 25 cm tall, densely woolly with soft white hairs. Leaves alternate, sessile, (1) 3–4 cm long, mostly oblanceolate, and entire. Flower heads in capitate clusters, small and straw-like, scarcely opening. Phyllaries scarious and often purple tipped (reddish purple or wine color), but sometimes only brownish. Florets discoid, minute, numerous, and probably self-fertilizing (autogamous), the corollas with purplish tips. Outer florets numerous and pistillate; inner florets 2–4 and bisexual. Achenes 0.3–0.5 mm long; pappus bristles united into a ring and readily deciduous as a unit (a feature of the genus).

Known in the flora area only from Bull Pasture in the Ajo Mountains where it was found in dried pools along a small rocky arroyo; growing with *Androsace occidentalis*, *Erythranthe cordata*, *Festuca octoflora, Myosurus cupulatus, Myriopteris wrightii*, *Poa bigelovii, Pterostegia drymarioides*, *Triodanis biflora*, and *Veronica peregrina*. It does not extend farther into the desert.

Figure 50. *Gamochaeta stagnalis*. Intermittent stream, Bull Pasture, 18 Mar 2005.

Southwestern California, southern Arizona, southwestern New Mexico, and Mexico including Baja California, Baja California Sur, Chihuahua, Coahuila, Durango, Nuevo León, San Luis Potosí, Sinaloa, Sonora, and southward at least to Colima and Zacatecas. *Gamochaeta stagnalis* is probably not native in southwestern California and northwestern Baja California. It is often weedy and also misidentified and confused with seemingly closely related species (Nesom 2004, 2012).

OP: Bull Pasture: Bedrock drainage with shallow sediments that flows seasonally and retains moisture, 3160 ft, 18 Mar 2005, *Rutman 20050318-9*; Small bedrock arroyo or canyon bottom, dried up pool with a sheet of dried algae, 10 Apr 2005, *Felger 05-213*.

Geraea

Two species; *Geraea viscida* is a chaparral species in California and Baja California. *Geraea* is allied to *Encelia*, and natural but mostly sterile hybrids are known. Heliantheae, Ecliptinae.

Geraea canescens Torrey & A. Gray
Desert sunflower, desert gold. Figure 51.

Figure 51. *Geraea canescens*. (A, B & D) Organ Pipe headquarters area, 8 Mar 2008. (C) Coffeepot Mt, Sauceda Mts, Maricopa Co., 27 Feb 2005. (E) An exceptional year on the sandy flats of Lago Seco, Goldwater Range, Maricopa Co., 18 Mar 2014.

Cool-season ephemerals, generally seen in spring, 15–100 cm tall, usually with 1 to several ascending branches, or sometimes much-branched above. Upper stems and outer phyllaries densely glandular. Leaves alternate (2.5) 5–13 cm long, rough to the touch with coarse white hairs, oblanceolate to obovate or elliptic, coarsely toothed, or smaller leaves sometimes entire; petioles winged or the leaves sessile; upper stem leaves reduced. Phyllaries graduated, the inner and longer ones 5–9 mm long, dark green, linear-lanceolate, strikingly outlined with white hairs (ciliate). Flower heads sunflower-like, showy, closing at night, opening after sunrise, the rays bright yellow, sterile, (0.8) 1.5–3.2 cm long, the disk yellow-orange, with chaffy bracts clasping the disk achenes and falling with them. Achenes flat, blackish, 5–7 mm long with whitish margins continuous with 2 slender, persistent awns. Flowering December–April.

One of the most abundant and conspicuous wildflowers in the region; sandy soils of the desert floor and dunes, desert pavements and poorly drained flats, and sometimes on lower slopes. Sometimes on moderately saline soils. It has been in the western part of the flora area for at least 8600 years.

Baja California, northwestern Sonora, southwestern Arizona, southeastern California, southern Nevada, and southwestern Utah.

OP: 8 mi S of Growler Well, *Nichol 17 Mar 1939*. Quitobaquito, 27 Nov 1939, *Harbison 26178* (SD). NW corner of Monument, 21 Mar 1941, *McDougall 8*. Growler Valley, Sep 1951, *Supernaugh 450*. Camino Dos Republicas 6 mi E of Hwy 85, 11 Feb 1978, *Bowers 1041*. Bates Well, 12 Mar 2003, *Felger 03-304*.

CP: Pinacate Lava Field, 26 Mar 1932, *Shreve 5927*. 14 mi W of Papago Well, 18 Feb 1979, *McLaughlin 1962*. Tule Well, 29 Apr 1986, *Hodgson 4128* (DES). The Playa, 20 Mar 1992, *Telewski 51*. Christmas Pass, 14 Apr 1992, *Steinmann 278*. Pinta Sands, 11 Apr 1993, *Felger 93-425*.

TA: Butler Mts, *Van Devender 27 Mar 1983*. Flats E of Tinajas Altas Mts, 2 Mar 2014, *Van Devender*, observation (MABA in SEINet). †Butler Mts, achenes, 3820 & 8570 ybp.

Gutierrezia – Snakeweed

Ephemerals and small woody shrubs or subshrubs. Leaves alternate and narrow. Herbage and phyllaries glandular-punctate and resinous. Flower heads small, the phyllaries graduated, persistent, with ray and disk florets. Pappus present or occasionally reduced. The two species in the flora area are strikingly different.

Western North America and western South America; 28 species. Astereae.

1. Spring ephemerals; rays white, the disk yellow..... **Gutierrezia arizonica**
1. Perennial subshrubs; all flowers yellow..... **Gutierrezia sarothrae**

Gutierrezia arizonica (A. Gray) M.A. Lane

[*Greenella arizonica* A. Gray. *Xanthocephalum arizonicum* (A. Gray) Shinners]

Arizona snakeweed. Figure 52.

Small, delicate spring ephemerals, usually less than 20 cm tall; stems slender, single or few-branched above. Leaves at base of plant, often in a basal rosette, narrowly elliptic-oblanceolate or lanceolate, 1–2 mm wide, and reduced or absent above. Flower heads single or several on slender peduncles. Rays white, 6–7 mm long, the disk yellow. Achenes 1–1.5 mm long, densely hairy with bulbous-tipped hairs, the pappus of scales hidden by the achene hairs.

Usually in poorly drained, silty, fine-textured soil of dried mud puddles in swales, floodplains, and washes in valley bottoms with other small spring ephemerals such as *Eriophyllum lanosum*, *Festuca octoflora, Logfia arizonica*, *Plantago ovata*, and *Schismus barbatus*. Widely

scattered, usually in small, localized populations; eastern part of Cabeza Prieta and at least in the southeastern and northwestern parts of Organ Pipe.

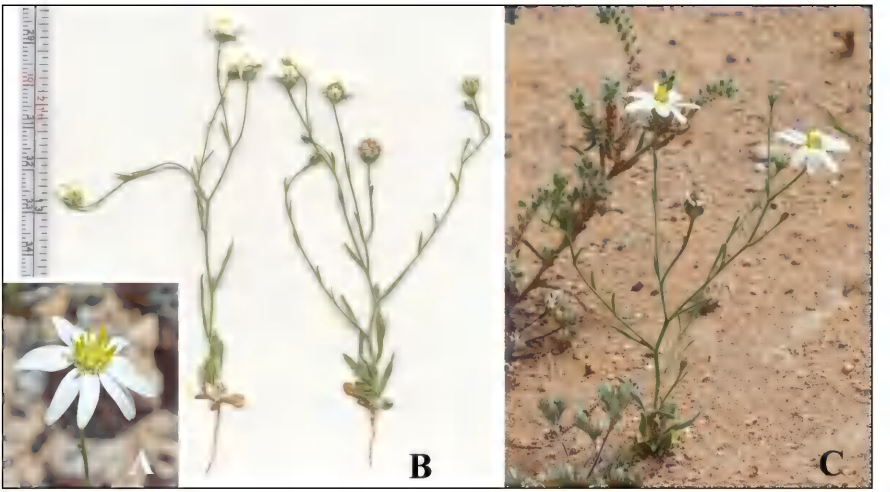

Figure 52. *Gutierrezia arizonica*. (A) Desert pavement, first mile of North Puerto Blanco Drive, 19 Mar 2015. (B & C) Near Lost City, San Cristobal Valley, 13 Mar 2014.

Eastward in southern Arizona and northern Sonora. Although a spring ephemeral in the flora area, farther east and at higher elevations it also flowers with summer rains.

OP: Bates Well, *Nichol 26 Apr 1939*. 3 mi S of junction of Bates Well Road and road to Cabeza Prieta Refuge, 30 Mar 1978, *Bowers 1154*. E of Dos Lomitas, 31 Mar 2003, *Rutman 2003-439*. Growler Valley, 11 Apr 2003, *Rutman 2003-465*.

CP: San Cristobal Wash, 11 Apr 1992, *Harlan 168*. Daniels Arroyo at Charlie Bell Road, 10 Apr 1993, *Felger 93-346*. Growler Wash, 10 Apr 1993, *Felger 93-367*.

Gutierrezia sarothrae (Pursh) Britton & Rusby
Broom snakeweed; *hierba de la víbora*; siw tadsagĭ. Figure 53.

Subshrubs 40–60 cm tall; stems woody below, slender and numerous, mostly erect to ascending; herbage and phyllaries sticky, resinous. Leaves mostly 2–5 cm × 0.5–1.3 mm, narrowly linear, with moderately sparse pubescence of short white hairs. Flower heads 4–5 mm long, in dense, much-branched terminal clusters; involucres 3.5–4.5 × 2.5–3 mm, persistent, the phyllaries thick and with a resin pocket near the tip; with bright yellow ray and disk florets, the florets (ray and disk) 6–14. Achenes 1.3–1.5 mm long, the surface obscured by short, white, ascending hairs; pappus of membranous scales about as long as achenes on disk florets, shorter on ray achenes. Flowering mostly September and October.

Mountains in Cabeza Prieta and Organ Pipe including to the crestline in the Ajo Mountains. Often among grasses and on rocky slopes, sometimes in rock crevices. This or one or two similar species grew in Organ Pipe mountains from about 13,500 to at least 32,000 years ago.

Central Mexico to western Canada.

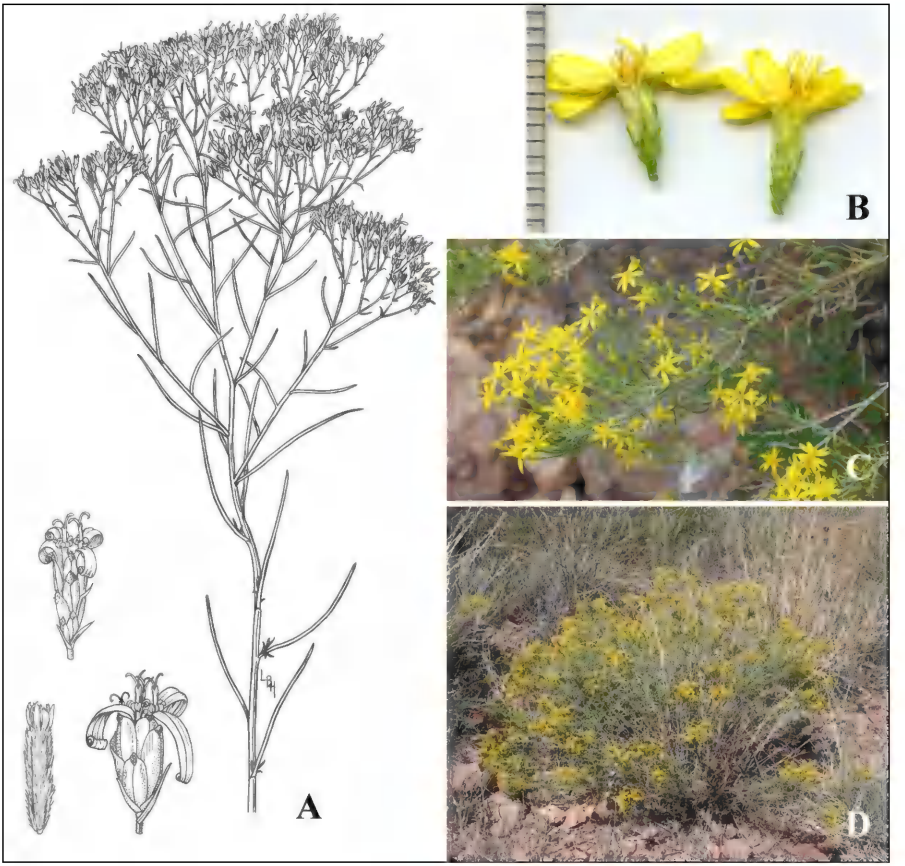

Figure 53. *Gutierrezia sarothrae*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon above Alamo Well, 3 Sep 2014. (C) Bull Pasture Trail, 19 Sep 2014. (D) Arch Canyon, 21 Sep 2008.

OP: Bull Pasture trail, 5 Nov 1977, *Bowers 935*. Alamo Canyon, 17 Oct 1987, *Baker 7567* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-283*. Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-24*. †*G.* cf. *sarothrae*: Alamo Canyon, involucres, 13,500 to 32,000 ybp (3 samples); Montezuma's Head, involucres, 17,830 to 21,840 ybp (3 samples); Puerto Blanco Mts, on ridge, involucres, 14,120 ybp.

CP. Heart Tank, *Simmons Sep 1963*. Tule Tank drainage, 23 Mar 1992, *Harlan 130*. Eagle Tank, 13 Jun 1992, *Felger 92-584*. Canyon S of Heart Tank, 14 Jun 1992, *Felger 92-593*.

Gymnosperma

This genus of one species is related to *Gutierrezia*. Astereae.

Gymnosperma glutinosum (Sprengel) Lessing
Gumhead. Figure 54.

Suffrutescent perennials or small shrubs, often 0.6–1 m tall; glabrate (minutely scabrous). New growth—stem tips, leaves, and flower heads—glistening with viscid, glandular exudate, especially in dry seasons. (This exudate is water soluble because the surfaces are virtually devoid of visible exudate after rainy periods.) Leaves alternate, sessile, tardily drought deciduous, shiny green, densely gland-dotted, linear-lanceolate to linear-oblanceolate, 2–8 cm × 2–4.5 mm, the midrib on lower surface prominently keeled. Flower heads 1.5 mm wide, in dense terminal clusters, and persistent; phyllaries graduated, membranous with a resin pocket near the tip, the larger phyllaries 3–4 mm long. Flowers bright yellow; ray florets small and inconspicuous with reduced corollas and not exceeding the phyllaries; ray and disk florets fertile. Achenes 1.3–2 mm long, cylindrical, with minute hairs; pappus reduced to an almost microscopic ring. Flowering nearly all year, especially during the warmer months.

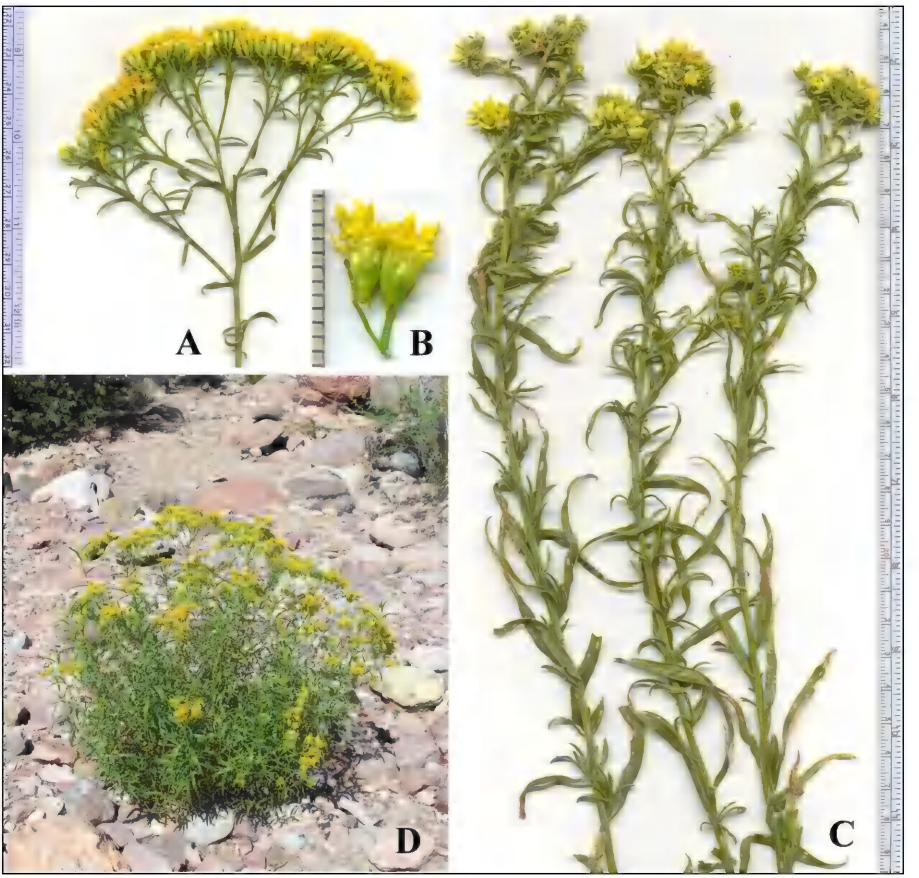

Figure 54. *Gymnosperma glutinosum*. (A & D) Alamo Canyon near Alamo Well, 7 Sep 2013. (B) Wash draining N end of Diablo Mts, N end of Ajo Mountain Drive, 26 Aug 2014. (C) Arch Canyon, 10 Sep 2008.

Widely scattered, seldom common, mostly on rocky slopes and mountain arroyos or canyons, extending to the summits of the drier mountains. The plants are amazingly drought resistant and often retain bright green foliage and even produce some flowers during extended drought when nearly all of the surrounding plants are dormant and leafless. Fossil specimens from the Ajo and Tinajas Altas mountains date from 15,700 years ago.

Southern Arizona to southern Texas and Guatemala.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. Alamo Canyon, 2400 ft, 3 Dec 1977, *Bowers 988*. Kuakatch Wash, near E boundary, *Rutman 23 Oct 1999* (ORPI). Diablo Mts, 807 m, shaded base of N-facing cliff, 22 Sep 2013, *Rutman 20130922-14*. †Montezuma's Head, involucre, 13,500 ybp.

CP: Tule Tank, 15 Apr 1941, *Benson 10802*. Buckhorn Tank, *Dodson 28 May 1972* (CAB). Eagle Tank, 13 Jun 1992, *Felger 92-90*. Cabeza Prieta Peak, 24 Mar 1995, *Yeatts 3701* (CAB). Sierra Pinta, summit, *Cain 15 Nov 2003*. Heart Tank and Tuseral Tank, 14 & 15 Jun 1992, *Felger*, observations.

TA: Tinajas Altas, 19 Feb 1979, *McLaughlin 1969*. †Tinajas Altas, involucres, achenes, 1230 to 15,680 ybp (10 samples).

Helianthus – Sunflower; *mirasol*

Large ephemerals or perennial herbs, with coarse or prominent hairs. Leaves mostly alternate, or sometimes opposite below, petioled, and often with ovate blades. Flower heads large and showy on prominent peduncles. Those in the flora area have sterile ray florets with bright yellow corollas, and a reddish purple disk with fertile florets. Achenes thick, laterally compressed, enclosed by prominent chaffy bracts; pappus usually with a pair of deciduous awned scales.

Native to North America including Mexico; 52 species. Heliantheae, Helianthinae.

1. Leaves green, sparsely hairy; phyllaries ovate, at least 4 mm wide, the attenuate tip at least 4 mm long; disturbed habitats..... **Helianthus annuus**
1. Leaves gray-green, moderately to densely hairy; phyllaries lanceolate, 1.8–3.5 mm wide, the attenuate tip 1 mm long or less or absent; dunes..... **Helianthus niveus**

****Helianthus annuus** Linnaeus

Sunflower; *mirasol*. Figure 55.

Robust, warm-weather ephemerals, potentially to about 2 m tall, with harsh (hispid) hairs. Leaves petioled, the blades ovate, 10–40 cm long, the margins serrate. Phyllaries green, ovate, the margins usually ciliate. Heads large, more than 10 cm wide. Rays bright yellow, 2.5–5 cm long. Achenes glabrous; pappus of 2 lanceolate scales and sometimes additional obtuse scales.

Rare along Hwy 85 and not established in the flora area. Common along roadsides across much of Arizona. This is the common weedy sunflower from northern Mexico to western Canada.

Cultivars of this species, usually with a single, very large head, are major oil-seed crops and the only North American composite to be developed as a major agricultural crop.

OP: Hwy 85 near milepost 68, road shoulder, *Rutman 21 Jul 1998*.

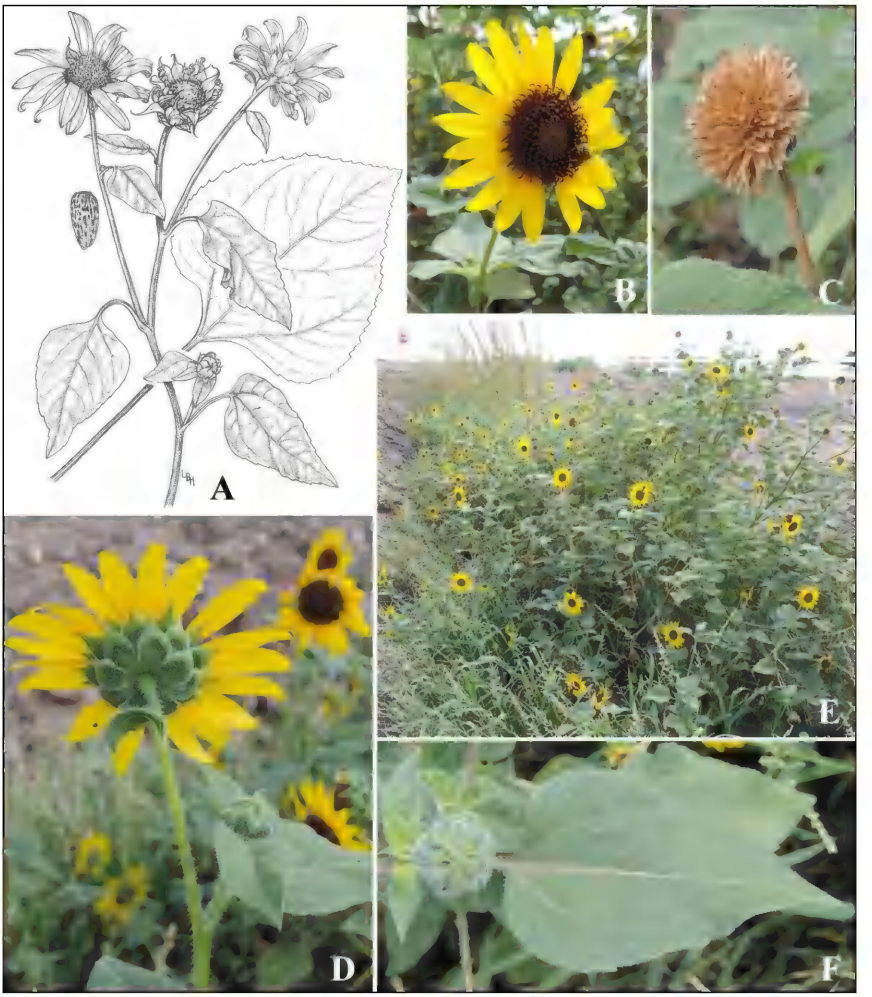

Figure 55. *Helianthus annuus*. (A) By Lucretia Breazeale Hamilton. (B–F) Hazen Road, about 1 mi E of Hwy 85, Buckeye, Maricopa Co., 9 Aug 2016.

Helianthus niveus (Bentham) Brandegee subsp. **tephrodes** (A. Gray) Heiser
Dune sunflower; *mirasol de las dunas*; hi:wai. Figure 56.

Non-seasonal ephemerals and perhaps sometimes short-lived perennials, 0.5–1+ m tall. Herbage and phyllaries green to whitish, villous to canescent. Leaves opposite below, alternate and sometimes opposite above, mostly 4–12 cm long, the petioles prominent, the blades lanceolate to broadly ovate, the margins entire or serrated. Heads including rays (3.5) 4–9 cm wide; phyllaries graduated, lanceolate, 8–10 × 1.8–3.5 mm, the attenuate tip to 1 mm long or absent. Rays bright yellow, mostly 2–3 cm long, the disk florets dark brownish purple. Achenes 4–5 mm long, thick

(rhombic in cross section), mottled black and pale tan, with long, silky, forward-pointing hairs (or the achenes sometimes markedly flattened, blackish and without hairs, these perhaps immature); pappus deciduous, of several shorter scales and 2 larger, awn-tipped scales. Flowering in spring and with summer-fall rains.

Common on dunes in Cabeza Prieta and west of the Tinajas Altas Mountains.

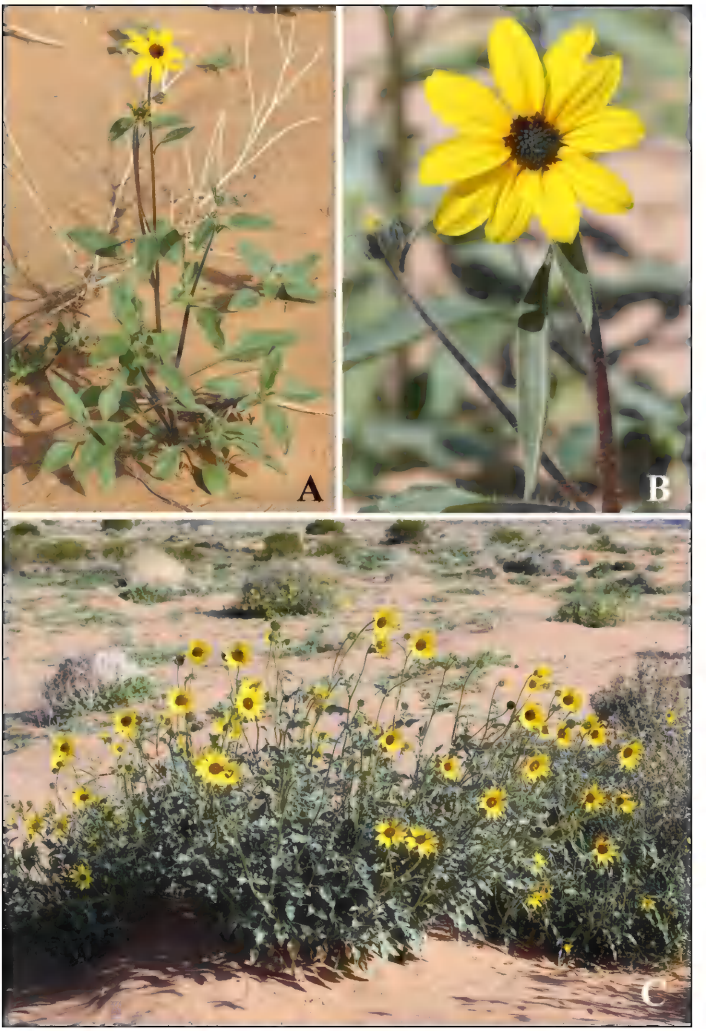

Figure 56. *Helianthus niveus* subsp. *tephrodes*. Dunes 20 mi S of Sonoyta on Mex Hwy 8, Sonora: (A) 6 Feb 2014. (B) 16 Feb 2008. (D) Pinta Sands near Camino del Diablo, 11 Feb 2014.

This subspecies occurs in sand soils, especially dunes, in southeastern California and southwestern Arizona, and adjacent northernmost Sonora. Subspecies *niveus* occurs on the Baja California Peninsula and the Sonora coast southward to the Guaymas Region.

CP: Pinta Sands: *Monson 21 Feb 1958* (CAB); 17 Apr 1983, *Hodgson H-2076* (DES); 15 Sep 1992, *Felger 92-775.*

††**Heterotheca** sp.
Camphor weed

An unidentified camphor weed grew at Tinajas Altas for more than 33,000 years, until about 4000 years ago. This is the only record for this genus in the flora area. The nearest population of a member of this genus is the narrow dune endemic, *H. thiniicola* (Rzedowski & Ezcurra) B.L. Turner, in the Gran Desierto of northwestern Sonora. This genus includes 28 species in North America. Astereae.

TA: †Tinajas Altas, achenes, 4010 to >37,000 ybp (13 samples).

Hymenoclea, see **Ambrosia**

Hymenothrix

Southwestern United States and Mexico; 5 species. Heliantheae, Chaenactidinae.

Hymenothrix wislizeni A. Gray
Thimblehead. Figure 57.

Ephemerals or short-lived herbaceous perennials, sometimes propagating by short rhizomes. Stems often 50–70 cm tall. Densely pubescent with glandular hairs and short, coarse, white non-glandular hairs; young growth or basal part of plant viscid-sticky, the subsequent herbage less so. Stems erect, mostly 50–70 cm tall. Leaves 2 or 3 times pinnately dissected, the larger leaves 6–10+ cm long, early leaves in a basal rosette, the stem leaves with fewer segments. Inflorescences much-branched, flat-topped, the heads crowded in dense terminal clusters. Heads 8–10 mm wide, the phyllaries green, 2.7–4 mm long. Ray and disk florets bright yellow, bisexual and fertile. Achenes 2.5–4 mm long, 4- or 5-angled; pappus of 10–13 persistent slender scales with transparent margins, the midrib extending into an awn. Flowering April and September–December.

Often in open areas in sandy-gravelly washes and sometimes along roadsides. Usually in small, isolated populations in the lowlands of Organ Pipe and two records in Cabeza Prieta.

Southern and central Arizona, southwestern New Mexico, northern Sonora, and northwestern Chihuahua.

OP: Rancho Bonito, 30 Nov 1939, *Harbison 26196.* N of headquarters, 26 Mar 1965, *Ranzoni 357* (ORPI). 4 mi N of Visitor Center, tributary to Cherioni Wash, *Warren 10 Nov 1983.* Aguajita, 23 Oct 1987, *Felger 87-266.* Kuakatch Wash near E boundary, *Rutman 23 Oct 1999* (ORPI).
CP: Little Tule Well, 12 Jun 1992, *Felger 92-536.* Daniels Arroyo, 27 Sep 1992, *Harlan 332.*

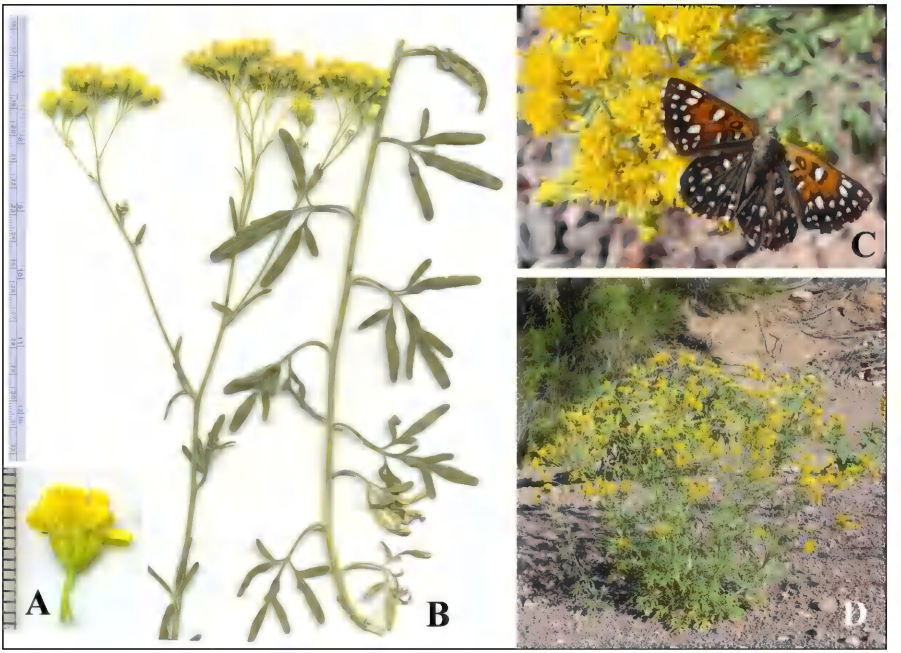

Figure 57. *Hymenothrix wislizeni*. Why: (A) 20 Sep 2014; (B) 8 Oct 2013. (C) Mormon Metalmark (*Apodemia mormo*), Alamo Wash near Hwy 85, 2 Nov 2013. (D) Wash crossing Hwy 85 within 2 mi of N boundary of Organ Pipe, 5 Oct 2013.

Hymenoxys

North America to South America; 25 species. Heliantheae, Gaillardinea.

Hymenoxys odorata de Candolle

Bitterweed. Figure 58.

Aromatic spring ephemerals 20–45 cm tall, sparsely pubescent and dotted with microscopic globules of resin-like exudate. Leaves in basal rosettes withering as the leafy stems develop; leaves pinnately dissected into thick, blunt-ended, slender segments. Flower heads 5–10 mm wide (not including the rays), with bright yellow ray and disk florets, the rays 7–10 mm long, 8–10 in number, turning down at maturity and persistent. Phyllaries in 2 or 3 rows, densely villous, the outer phyllaries rigid, strongly arched or broadly keeled, conspicuously thickened and united at their bases; inner phyllaries separate, longer than the outer ones. Achenes 2 mm long, densely silvery-silky haired; pappus of 5 or 6 acuminate to awn-tipped scales.

Fine-textured, clay soils of playas in Cabeza Prieta, often locally and seasonally abundant.

Arizona to Kansas and northern Mexico, and California only along the Colorado River at Parker.

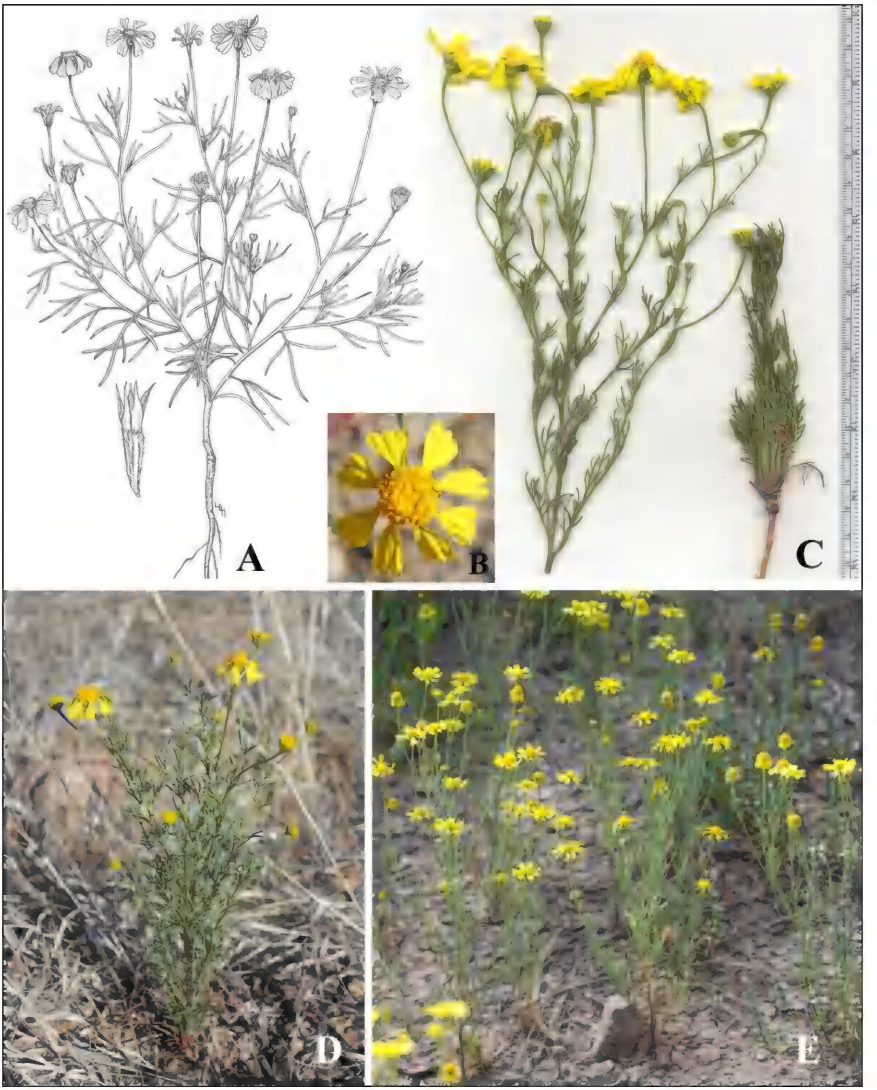

Figure 58. *Hymenoxys odorata*. (A) By Lucretia Breazeale Hamilton. (B, C & E) Roadside ditch, Pinacate Junction, Mex Hwy 2, Sonora, 5 Mar 2014. (D) Roadside near El Huerfano, Mex Hwy 2, Sonora, 5 Mar 2014.

CP: Pinta Playa, *Monson 21 Feb 1958*. Marker 81 off the Camino del Diablo, W of O'Neill Hills, *Harlan 20 Mar 1983*. Las Playas, 10 Apr 1993, *Felger 93-382*.

Isocoma

Southwestern United States and Mexico; 16 species. A genus segregated from *Haplopappus*. Astereae.

Isocoma acradenia (Greene) Greene var. **acradenia**
[*Haplopappus acradenius* (Greene) S.F. Blake. *Isocoma veneta* (Kunth) Greene]
Alkali goldenbush. Figure 59.

Resinous shrubs often 0.8–1 m tall with slender, brittle, shiny stems. Herbage copiously resinous-glutinous from the glands; young herbage with sparse, short, white hairs soon mostly covered in resin, the older herbage appearing glabrate. Leaves alternate, (1) 1.5–4.6 cm long, yellow-green, narrowly oblanceolate to lanceolate, the margins entire or few toothed. Flower heads usually clustered, (4) 4.5–6.5 mm wide, bright yellow with disk florets only. Phyllaries graduated, firm, linear-oblong, with a thin-walled, wart-like resin pocket near the tip. Achenes 2–3.5 mm long, ribbed, moderately to densely pubescent, with many coarse pappus bristles of uneven length. Flowering spring and late summer-fall.

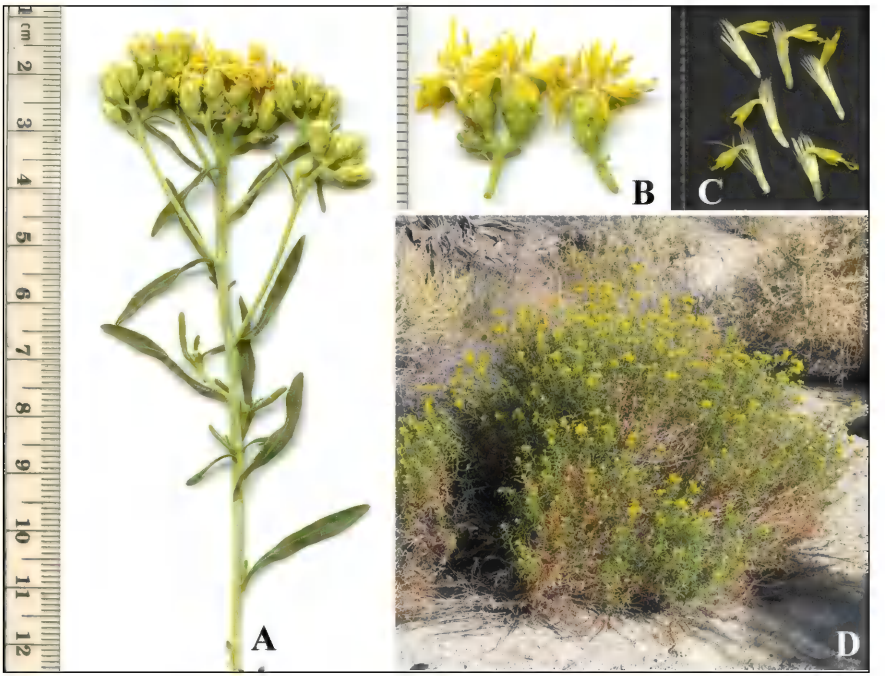

Figure 59. *Isocoma acradenia* var. *acradenia*. Quitobaquito: (A–C) 23 Sep 2014; (D) 20 Oct 2010.

Localized near waterholes and washes and their floodplains, often with saline soils. Especially common in Organ Pipe in the Quitobaquito area; also La Abra Plain, with *Atriplex polycarpa* near Dos Lomitas, and lower-elevation canyon bottoms in the Ajo Mountains. Simmons (1965, 1966) reported it from Tule Well in Cabeza Prieta.

Southwestern United States, Baja California, and Sonora.

Alkali goldenbush was used medicinally by many groups, including by the Cahuillas for "curing colds and sore throats" (Bean & Saubel 1972: 75) and by the Gila River Pimas as a disinfectant to treat sores (Rea 1997: 135), for inflammation, for "cleansing the blood" (Hrdlička 1908: 246), and as a deodorant (Rea 1997).

OP: Quitobaquito, *Nichol 28 Apr 1939*. Arch Canyon, *Fouts 15 Jun 1948* (ORPI). Dripping Springs, *Simmons 11 Oct 1963*. Aguajita, 23 Oct 1987, *Felger 87-272*. 3 mi W of Dos Lomitas, *Rutman 29 Aug 2001* (ORPI).

CP: Tule Well, *Simmons Sep 1964* (specimen not located, cited by Simmons 1965, 1966).

Koanophyllon

Western United States to South America and West Indies; 115 species. A genus segregated from *Eupatorium*. Eupatorieae.

Koanophyllon palmeri (A. Gray) R.M. King & H. Robinson
[*Eupatorium palmeri* A. Gray. *E. solidaginifolium* A. Gray in part]
Umbrella thoroughwort. Figure 60.

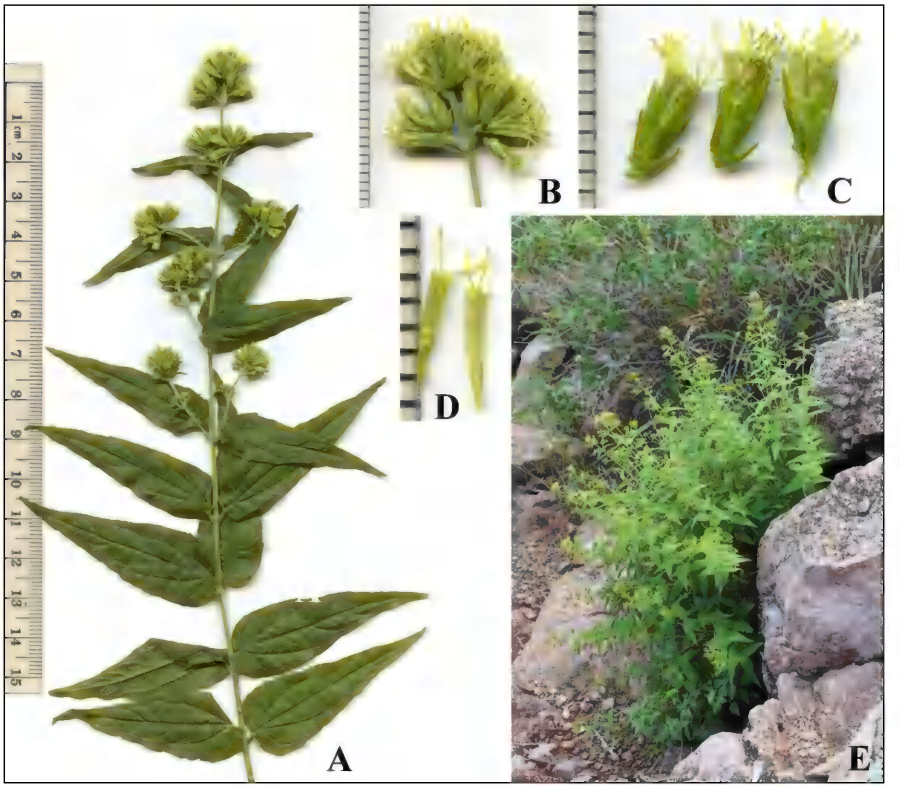

Figure 60. *Koanophyllon palmeri*. (A–D) Arch Canyon, 12 Jan 2014. (E) Estes Canyon, Bull Pasture Trail, 19 Sep 2014.

Low, spreading herbaceous perennials or subshrubs, sometimes to about 1 m tall. Leaves opposite, petioles short, the blades 3–6 cm long, lanceolate to triangular, relatively thin but firm and often shiny green, the margins entire or toothed, the margins and veins of lower leaf surfaces with short, hooked white hairs. Inflorescences rather open and divaricately branched. Flower heads of disk florets, the corollas whitish; involucres 3.5–4 mm wide. Achenes prismatic, 5-ribbed, pale brown, 1.5–1.6 mm long; pappus of many persistent barbellate bristles. Flowering mostly September and October, and sometimes late April and May.

Ajo Mountains including Alamo, Arch, and Boulder canyons, and rocky slopes to the crestline.

Eastward and northward in Arizona to New Mexico, and western Mexico.

The western Mexico and Arizona populations of *K. solidaginifolium* (A. Gray) R.M. King & H. Robinson are segregated as *K. palmeri*. As now interpreted, *K. solidaginifolium* ranges from Texas southward to Michoacán and Coahuila, forming part of a complex of related taxa.

OP: Alamo Canyon: *Nichol 4 May 1939* (ORPI); 13 Dec 1939, *Harbison 26254*; South Alamo Canyon, 29 Sep 1988, *Wilson 200*. Boulder Canyon, 3 May 1978, *Bowers 1293* (ORPI). Arch Canyon, 900 m, 2 Dec 1990, *Felger 90-528*. Middle fork of Alamo Canyon, near the crestline, 15 Mar 2003, *Rutman 2003-323* (ORPI). Bull Pasture trail in Estes Canyon, 3000 ft, 10 Apr 2005, *Felger 05-192*.

Lactuca – Lettuce

North America to Central America, Eurasia, and Africa; 75 species. *Lactuca sativa* is lettuce. Cichorieae.

***Lactuca serriola** Linnaeus

Prickly lettuce, compass plant. Figure 61.

Ephemerals often germinating in late winter or spring, flowering in late spring and summer, and sometimes surviving through the summer. Highly variable in size, occasionally reaching 2+ m tall but usually much shorter. Stems shiny white, mostly unbranched below; herbage often with stiff bristles. First leaves in a basal rosette, the stem leaves often 10–22 cm long, pinnatifid, turned basally to hold the leaf edgewise and upright in a north-south plane, hence the name "compass plant"; midvein on lower leaf surfaces with a row of thick stiff hairs, but not on leaves produced in fall. Inflorescence a terminal, open panicle. Involucres enlarging after flowering to 11–15 mm long, the phyllaries green, the larger ones conspicuously broadened at base, the tips with small tufts of hair. Flowers pale yellow, the florets ray-like (ligulate). Achene body 2.8–3 mm long, laterally compressed, with short bristles near apex, and a slender beak as long as to much longer than the body and supporting a pappus of silky white hairs.

Usually locally in disturbed habitats and occasional in natural areas, such as the San Cristobal Wash and south end of Coyote Wash in the Lechuguilla Valley. Widely scattered in Organ Pipe, but scarce in natural areas.

Native to Europe, now weedy in many parts of the world. The seeds are the source of Egyptian lettuce-seed oil, used in food for its pleasant flavor and as a semi-drying oil.

OP: Puerto Blanco Drive, 3.4 mi E of turnoff to Senita Basin, 20 Jun 1979, *Bowers 1756*. Quitobaquito, 18 Mar 1998, *Rutman*, observation. Burned area 3 mi E of Dos Lomitas, *Rutman 29 Aug 2001* (ORPI).

CP: San Cristobal Wash at Camino del Diablo, 10 Apr 1993, *Felger 93-375*.

TA: Lechuguilla Valley at Camino del Diablo, S end of Coyote Wash, locally abundant, some dry dead stalks from last year 2+ m in height, 28 Mar 2010, *Felger 10-162*.

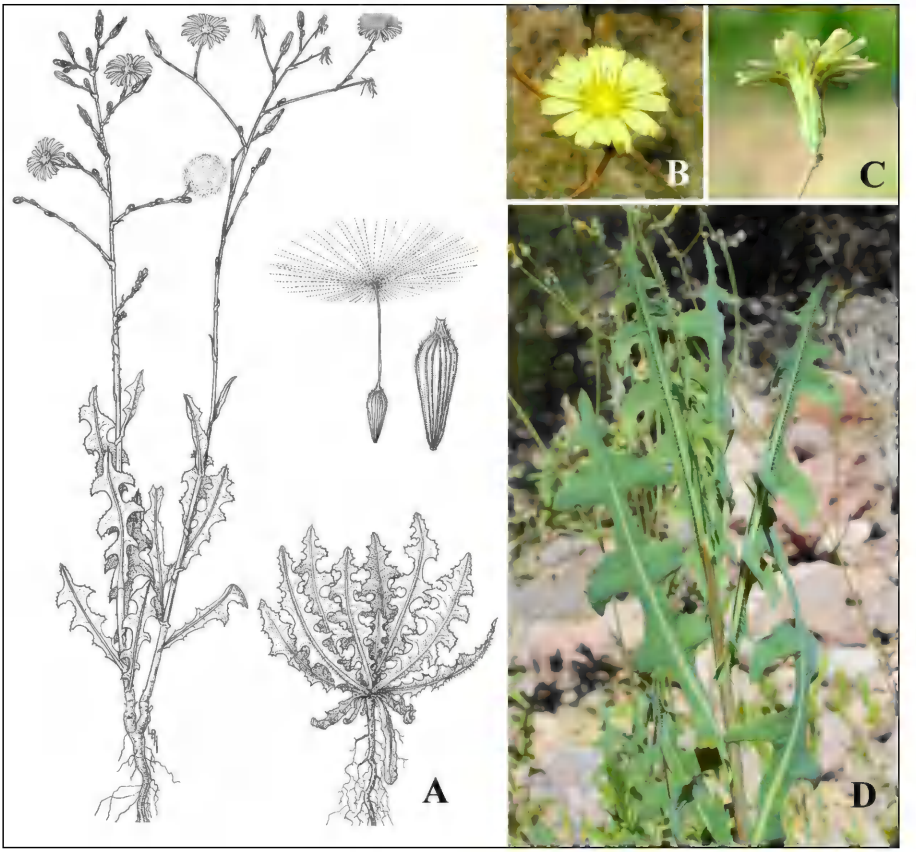

Figure 61. *Lactuca serriola*. (A) By Lucretia Breazeale Hamilton. (B & C) Boulder, Garfield Co., UT, 29 Jul 2001, photos by Max Licher (SEINet). (D) Alamo Canyon, 4 Apr 2015.

Leucosyris

Small xerophytic ephemeral, annual or perennial herbs; leaves alternate. Nine species in southwestern United States and northern Mexico. Astereae.

1. Stems leafy except in extreme drought; heads with lavender rays and yellow disk florets. ..... **Leucosyris arida**
1. Stems sparsely leaved to nearly leafless; heads with disk florets only, flowers bright yellow. ..... **Leucosyris carnosa**

Leucosyris arida (B.L. Turner & D.B. Horne) Pruski & R.L. Hartman
[*Arida arizonica* (R.C. Jackson & R.R. Johnson) D.R. Morgan & R.L. Hartman. *Machaeranthera ammophila* Reveal. *M. arida* B.L. Turner & D.B. Horne. *M. arizonica* R.C. Jackson & R.R. Johnson, Rhodora 69 (780): 476–480, 1967. *M. coulteri* var. *arida* (B.L. Turner & D.B. Horne) B.L. Turner]
Arid tansy-aster. Figure 63.

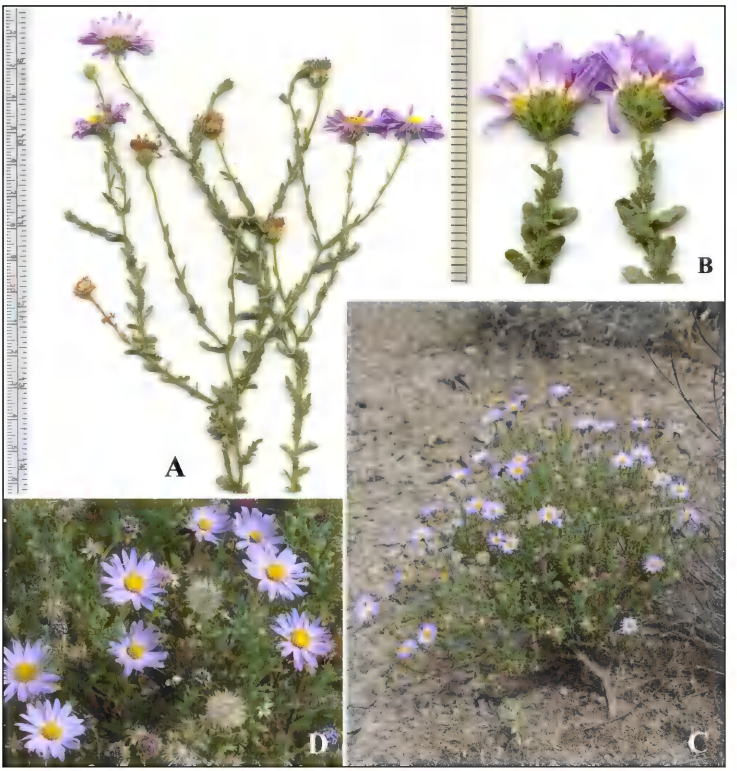

Figure 63. *Leucosyris arida*. Río Sonoyta floodplain near El Huerfano, Sonora: (A) 28 Mar 2013; (C & D) 6 Feb 2014. (B) Quitobaquito, 23 Sep 2014.

Non-seasonal ephemerals to short-lived perennials depending on soil moisture, usually less than 75 cm tall, with a well-developed taproot; plants glandular pubescent. First leaves 4–6 cm long, in a soon-withering basal rosette; stem leaves reduced, pinnatifid to toothed or essentially entire. Rays lavender, 8–12 mm long, ray achenes without a pappus. Disk yellow; disk achenes 1.5–2.2 mm long with a pappus of many unequal bristles. Flowering with sufficient soil moisture almost throughout the year, especially late spring and early summer.

Locally common in washes, sandy and alkaline flats, and roadsides in lowland areas of Organ Pipe and especially common in the Quitobaquito region. Also in the eastern and central part of Cabeza Prieta.

Northwestern Sonora, western Arizona, southeastern California, and southern Nevada.

OP: Near Cherioni Well, 9 Apr 1941, *McDougall 65*. Quitobaquito: Low rocky hillside and sandy soil around Quitobaquito Springs, *n* = 5, 31 Mar 1962, *Jackson 3043-1 & Johnson* (holotype of *Machaeranthera arizonica*, KANU; *Jackson 3043-4 & Johnson* (isotype, KANU); *Jackson 3043-2 & Johnson*, isotype of *M. arizonica*, ARIZ); 21 Aug 1983, *Sundberg 2109*. Cuerda de Leña Wash at N boundary, 31 Mar 1978, *Bowers 1157*. Puerto Blanco Mts, small wash near Red Tanks trailhead, 12 Sep 2013, *Rutman 20130912-12*.

CP: Charlie Bell Well: *Johnson 26 Mar 1960*; 26 Sep 1992, *Harlan 314*. Tule Well: 28 Mar 1970, *Duncan 7*; 11 Apr 1993, *Felger 93-435*.

Leucosyris carnosa (A. Gray) Greene
[*Arida carnosa* (A. Gray) D.R. Morgan & R.L. Hartman. *Aster carnosus* (A. Gray) A. Gray ex Hemsley, not *A. carnosus* Gilbert. *A. intricatus* (A. Gray) S.F. Blake. *Leucosyris carnosa* var. *intricata* (A. Gray) Cronquist. *Machaeranthera carnosa* var. *intricata* (A. Gray) G.L. Nesom]
Alkali aster. Figure 64.

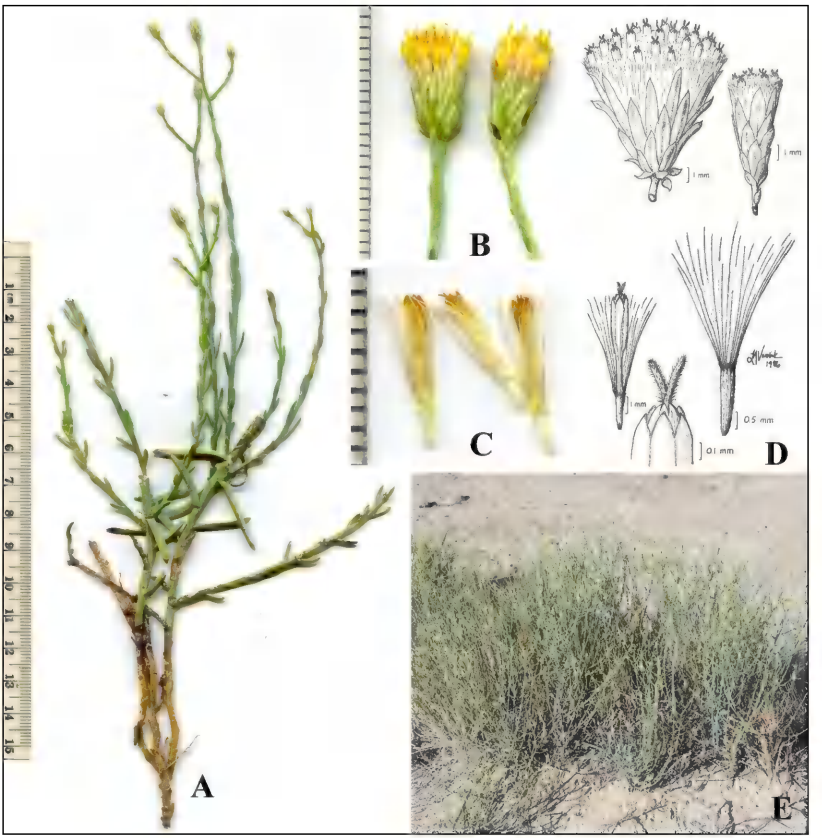

Figure 64. *Leucosyris carnosa*. (A–C, E) Quitobaquito, 23 Sep 2014. (D) Illustration by Linda Ann Vorobik.

Herbaceous perennials, essentially glabrous; sometimes dying back to ground level during drought. Stems often becoming partly decumbent, with few, often spreading branches. Leaves and young stems glaucous, often semi-succulent. Leaves few, often widely spaced, linear, entire, quickly deciduous, 1.4–3.6 cm long on new growth, mostly less than 1 cm, the upper leaves scale-like. Heads of bright yellow disk florets; ray florets none. Achenes 3–4 mm long, the surfaces obscured by white hairs; pappus of many unequal bristles 6–7 mm long. Flowering with sufficient soil moisture during the warmer months.

Saline soils at Quitobaquito, often on nearly barren ground with *Anemopsis californica, Juncus mexicanus,* and *Nitrophila occidentalis*.

Widely scattered in similar habitats in northwestern Sonora, Arizona, California, and Nevada.

OP: Quitobaquito: 25 Nov 1972, *Pinkava 10004* (ASU, DES, MO); 1 Apr 1980, *Stimson 233*; 23 Jul 1986, *Felger 86-219*.

Logfia

Diminutive or small cool-season ephemerals, usually white-woolly. Leaves alternate or seemingly whorled (*L. arizonica*), sessile or petioles obscure, the margins entire. Heads minute, sessile, or peduncles very short, generally grouped in clusters, the actual phyllaries none or vestigial and grading into the chaffy bracts; florets discoid. Outer florets pistillate, spirally arranged between outer bracts; inner florets bisexual, clustered in center of elongated, often tack-shaped receptacle. (Figure 65). Corollas reduced and dull in color, or sometimes pink or purple at tips. Achenes 0.6–1 mm long (Figure 66). Achenes of outermost pistillate florets at least relatively smooth and shiny, without a pappus. Achenes of inner bisexual florets slightly smaller, rougher (the surface with a cellular-patterned sculpturing) and duller or pubescent with unicellular trichomes (papillae), and a pappus of 12–30 deciduous white bristles minutely barbed above and sub-plumose below.

North America including Mexico, Eurasia, and north Africa, and some widely introduced elsewhere; 12 species. *Logfia* is a genus segregated from *Filago*. Gnaphalieae.

1. Branching pattern usually symmetric (2 equal side-branches at nodes, "pseudo-dichotomous"); flower heads and leaves mostly restricted to the branch nodes (forks); leaves nearly linear, usually much longer than the heads; florets inside innermost chaffy bracts 4–12, the minority (0–2) pistillate. ..... **Logfia arizonica**

1. Branching pattern usually asymmetric (irregular); flower heads and leaves more or less evenly distributed; leaves oblanceolate to oblong, usually not much longer than the heads; florets inside innermost chaffy bracts 12–40, the minority (3–7) bisexual.

2. Well-developed plants mostly spreading, wider than tall, branched from base without a dominant central stem; leaves mostly oblong to obovate, obtuse; achenes of innermost florets mostly smooth, with a pappus of 11–15 bristles falling away singly or in pairs; corolla lobes of inner florets mostly 5, usually yellowish..... **Logfia depressa**

2. Well-developed plants often erect and taller than wide, and often branched from a dominant central stem; leaves mostly oblanceolate, acute; achenes of innermost florets mostly sparsely papillate, with a pappus of 17–23 bristles falling away in complete or partial rings; corolla lobes of inner florets mostly 4, usually red-tipped..... **Logfia filaginoides**

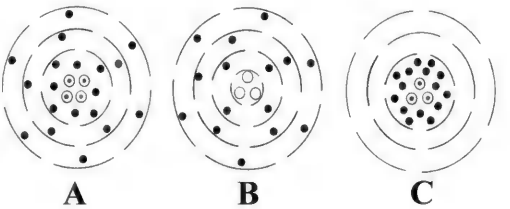

Figure 65. Filaginoid and gnaphaloid flower heads. Diagrams showing relative positions of bracts, pistillate florets (solid circles), and disk florets (open circles) comprising bisexual flowers (open circles with a dot) and staminate flowers (open circle without a dot). (A) *Logfia*; (B) *Stylocline*; (C) *Gnaphalium* sensu lato (*Gamochaeta* and *Pseudognaphalium*). Illustration by Matthew B. Johnson (from Felger 2000).

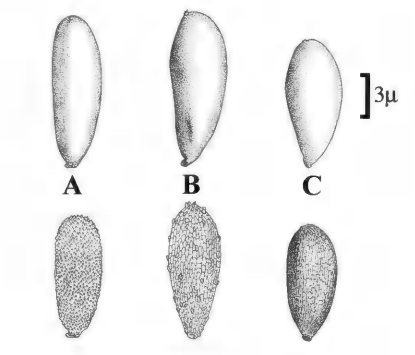

Figure 66. *Logfia* achenes. Upper row, achenes of outermost pistillate florets; lower row, achenes of bisexual inner florets. (A) *L. arizonica*; (B) *L. filaginoides;* (C) *L. depressa*. Illustration by Matthew B. Johnson (from scanning electron microscope photos by James D. Morefield, from Felger 2000).

Logfia arizonica (A. Gray) Holub
[*Filago arizonica* A. Gray. *Oglifa arizonica* (A. Gray) Chrtek & Holub]
Arizona fluffweed. Figure 67.

Plants usually less than 10 cm tall, often as wide as or wider than tall, with forked branching. Stems dark-colored, wiry, with relatively long internodes. Leaves whorled, those just below the flower heads usually conspicuously longer than the heads. Achenes 0.9–1 mm long. Pappus bristles falling away in complete or partial rings.

Widespread and often seasonally common, in sandy gravelly or clayish-silt soils, along washes, margins of waterholes and dirt tanks, canyon bottoms, and floodplains where water may temporarily accumulate and has recently dried up, and also in soil pockets on rocky slopes including higher elevations in the Ajo Mountains. Often growing intermixed with *L. filaginoides*.

Southern and central Arizona, southern California, Baja California, Baja California Sur, and northwestern Sonora.

OP: 2 mi WSW of Bates Well, rocky hill, 30 Mar 1978, *Bowers 1122*. Aguajita, 6 Apr 1988, *Felger 88-274*. W base of Santa Rosa Mts, *Rutman 3 Feb 2003* (ORPI). Middle fork Alamo Canyon near crestline of Ajo Mts, 3400 ft, 15 Mar 2003, *Rutman 2003-321*.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3945A* (CAB). Jose Juan Represo, 12 Jun 1992, *Felger 92-561*. Antelope Tank, 13 Jun 1992, *Felger*, observation. Papago Well, 26 Feb 1993, *Felger 93-138*.

TA: Coyote Water, 18 Mar 1998, *Felger 98-114*. Camino del Diablo at Coyote Wash, 10 Jan 2002, *Felger 02-9*.

Figure 67. *Logfia arizonica*. (A) Alamo Well, 16 Mar 2014. (B) Catalina Island, CA, 2 May 2003, photo by Gary A. Monroe (CalPhotos). (C) N foothills of Puerto Blanco Mts, 3 Mar 2005. (D) Bull Pasture, 7 Mar 2014.

Logfia depressa (A. Gray) Holub

[*Filago depressa* A. Gray. *Oglifa depressa* (A. Gray) Chrtek & Holub]. Figure 68.

Low, spreading plants, usually less than 5 cm tall, densely white-woolly, the internodes usually very short. Leaves mostly broad and blunt. Achenes (0.6) 0.7–0.9 mm long. Inner florets with pappus of 11–15 bristles falling away singly or in 2s.

Sandy-gravelly soils, especially in wash floodplains in the western part of Organ Pipe and low dunes in Cabeza Prieta; also in nearby northwestern Sonora. This inconspicuous and often misidentified species is probably more widespread, since it might be confused with *Stylocline*, especially *S. gnaphaloides*.

Northern Sonora to southern Nevada, southeastern California, and Baja California.

Figure 68. *Logfia depressa*. (A & C) Kuakatch Wash near Kuakatch Village, 11 Mar 2015. (B) Anza Borrego State Park, San Diego Co., CA, 27 Mar 2011, photo by Keir Morse (CalPhotos).

OP: Senita Basin Road, 4.5 mi S of Senita Basin, along wash, 23 Mar 1969, *Lehto L15440b* (ASU 18822, mixed collection with *Stylocline gnaphaloides*, det. James D. Morefield, 1992). 2.5 mi by road W of Hwy 85 on 2-way section of Puerto Blanco Drive, 1400 ft, 11 Apr 1978, *Bowers 1219* (ORPI). About 1 mi N of Bates Well road, towards Bluebird Mine, 22 Mar 2003, *Rutman 388* (ORPI).

CP: Pinta Sands encroaching E side of Pinacate Lava, growing with *Stylocline micropoides*, 11 Apr 1993, *Felger 93-400*.

Logfia filaginoides (Hooker & Arnott) Morefield
[*L. californica* (Nuttall) Holub. *Filago californica* Nuttall. *Oglifa californica* (Nuttall) Rydberg]
California fluffweed. Figure 69.

Plants characteristically slender with erect stems, often 3–20 cm tall. Herbage usually with woolly hairs. Stems more or less evenly leafy. Achenes 0.9–1 mm long. Inner florets with a pappus of 17–23 bristles falling away in complete or partial rings.

Widespread and often common, from low to high elevation, among rocks on slopes, bajadas, and along washes and canyons or at waterholes.

Arizona, California, Nevada, New Mexico, western Texas, Utah, Baja California, Baja California Sur, and Sonora southward to the Guaymas Region.

OP: Alamo Canyon, 12 Apr 1978, *Bowers 1248*. Twin Peaks, 4 Mar 1984, *Van Devender 84-48* (ORPI). Quitobaquito, 29 Mar 1988, *Felger 88-128*. Growler Mts, W of Growler Pass, 7 Mar 2003, *Rutman 2003-223* (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-285*.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3945B*. Agua Dulce Pass, 13 Jun 1992, *Felger 92-573*.
TA: Tinajas Altas, 18 Mar 1998, *Felger 98-144*.

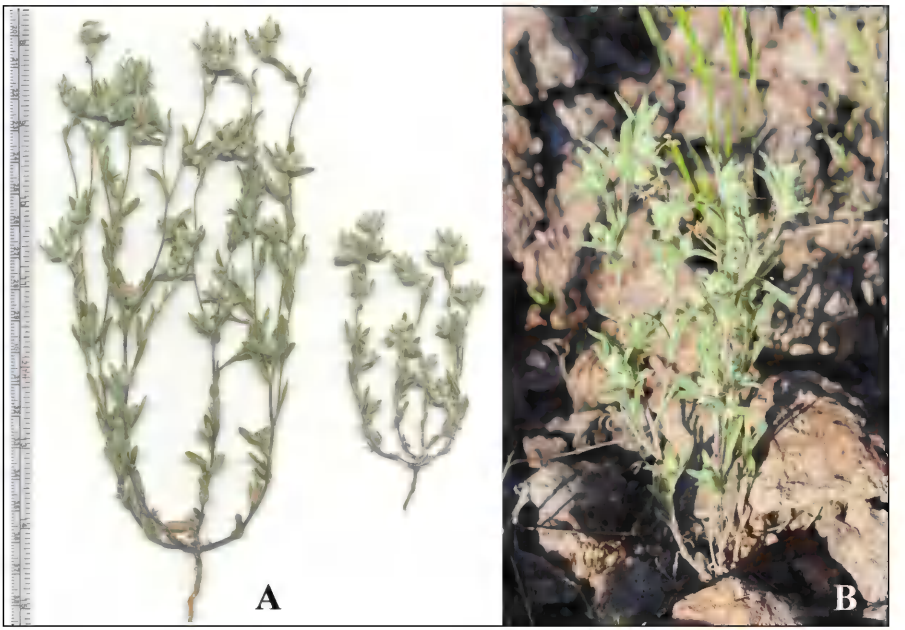

Figure 69. *Logfia filaginoides*. (A) Estes Canyon Trail, 7 Mar 2014. (B) Red Tanks parking area, Puerto Blanco Mts, 15 Mar 2005.

Machaeranthera

Two species; *Machaeranthera tanacetifolia* occurs in western North America including Mexico and Arizona. Astereae.

The large and unwieldy former *Machaeranthera*, once included in *Aster*, has been split into a number of monophyletic segregate genera (e.g., Morgan & Hartman 2003; Pruski & Hartman 2012). The former *Machaeranthera* sensu lato includes *Dieteria*, *Leucosyris*, and *Xanthisma.*

Machaeranthera tagetina Greene
[*Aster tagetinus* (Greene) S.F. Blake]
Mesa tansy aster. Figure 70.

Annuals, highly variable depending on soil moisture, often 10–25 cm tall, exceptionally robust plants to 75 cm tall. Leaves alternate, mostly 1- or 2-times pinnatifid. Flowering spring and summer, or possibly biennial in favorable situations. Densely pubescent with golden glandular-tipped hairs, sessile glands, and non-glandular hairs. Flower heads showy, involucres 3–9 mm high, the disk flowers yellow, the rays violet; ray and disk florets forming similar achenes and pappus, the achenes 2.5–3 mm long, sub-cylindrical, brown, densely covered with white hairs, and a persistent pappus of many barbellate bristles.

Figure 70. *Machaeranthera tagetina*. (A) Estes Wash at Ajo Mountain Drive, 21 Sep 2008. Alamo Canyon: 9B) 15 Sep 2013; 9C) 7 Sep 2013. (D) Estes Canyon, trail to Bull Pasture, 26 Aug 2008.

Ajo and Diablo mountains, especially at higher elevations, in open, sunny areas.

Southern to north-central Arizona, southwestern New Mexico and northeastern Sonora and adjacent Chihuahua; generally not in the drier regions of the Sonoran Desert.

OP: Arch Canyon, *Galiano 27 Aug 1986* (ORPI). Bull Pasture, 10 Apr 2005, *Felger 05-219*.

Malacothrix

Spring ephemerals with milky sap. Leaves mostly basal, the flower heads ligulate and often nodding in bud; florets yellow or white. Achenes ribbed, with or without a pappus. Cichorieae.

Native to western United States and northwestern Mexico, and introduced in South America; 20 species.

1. Leaves pinnatifid with slender thread-like segments; receptacle bristly; achenes 2.4 mm long. ..... **Malacothrix glabrata**
1. Leaves broad, with coarse teeth; receptacle not bristly; achenes 1.8–2 mm long.

2. Flower heads (1.5) 2.5–3 cm wide, one to few per stem; rays yellow with reddish streaks on underside, 4–6 mm longer than the phyllaries..... **Malacothrix fendleri**
2. Flower heads 1–1.5 cm wide, several to many per stem; rays uniformly white (or maybe yellowish), 1–2 mm longer than the phyllaries..... **Malacothrix sonorae**

Malacothrix fendleri A. Gray
Fendler's desert-dandelion. Figure 71.

Plants glabrate to mostly pubescent with cottony cobwebby hairs, and sparsely pubescent with gland-tipped hairs near the base of the plant and sometimes on lower leaf surfaces. Basal rosette leaves often 2.5–5.5 cm long, elliptic to oblanceolate, pinnately lobed or toothed. Stem leaves greatly reduced, the flowering stems bearing one to several flower heads. Flowers heads (1.5) 2.5–3 cm wide, the rays bright yellow, often with reddish tips, and reddish stripes on lower surfaces, larger rays often 10–13 mm long, with 5 prominent terminal teeth. Receptacle not bristly. Achenes brown, 1.8–2.2 mm long, slender and cylindrical, the tip forming a cup, the ribs extending into the terminal cup; pappus of 12–15 readily separating slender, white, barbellate bristles.

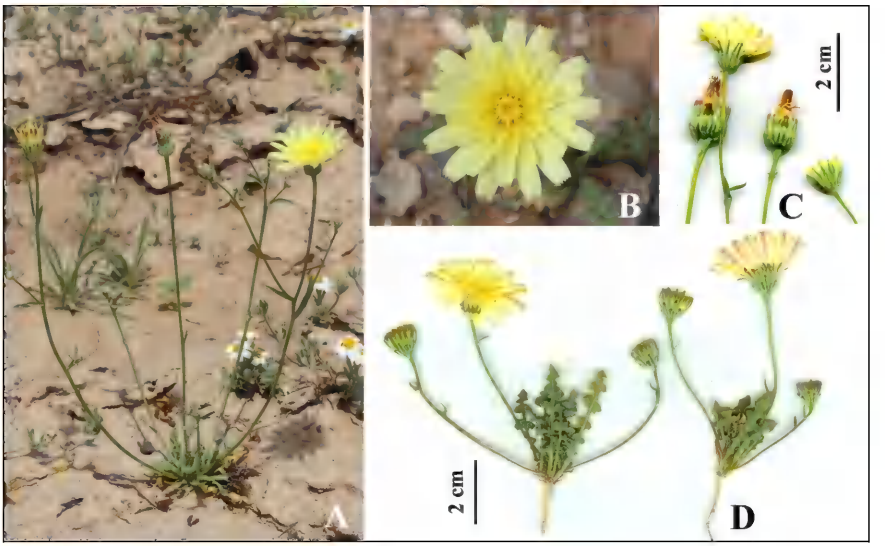

Figure 71. *Malacothrix fendleri*. (A) Lago Seco, Goldwater Range, Maricopa Co., 18 Mar 2014. (B & D) Sikort Chuapo Mts, 15 Mar 2008. (C) Hwy 85, mile 62, east of Why, 5 Apr 2015.

Washes and valley plains, often in low places where water temporarily settles. Eastern part of Cabeza Prieta and the northern part Organ Pipe; apparently not common.

Southern and eastern Arizona to western Texas, northern Sonora, and northern Chihuahua.

OP: Near junction of Bates Well Road and road to Cabeza Prieta, 3 Mar 1978, *Bowers 1139*. Hwy 85 near the N boundary, 31 Mar 1979, *Bowers 1611* (ORPI). Valley flat NE of Montezuma's Head, Ajo Mts, *Rutman 4 Apr 1998* (ORPI). Armenta Road, 11 Mar 2003, *Felger 03-259*.

CP: San Cristobal Wash: 16 Apr 1976, *Engard 869* (DES); 11 Apr 1978, *Reeves 6826-A* (ASU); Near San Cristobal Wash along Camino del Diablo, 11 Apr 1992, *Harlan 153*. Redtail Tank, *Cutler 17 Mar 1995* (CAB).

Malacothrix glabrata (A. Gray ex D.C. Eaton) A. Gray
[*M. californica* de Candolle var. *glabrata* A. Gray ex D.C. Eaton]
Desert dandelion. Figure 72.

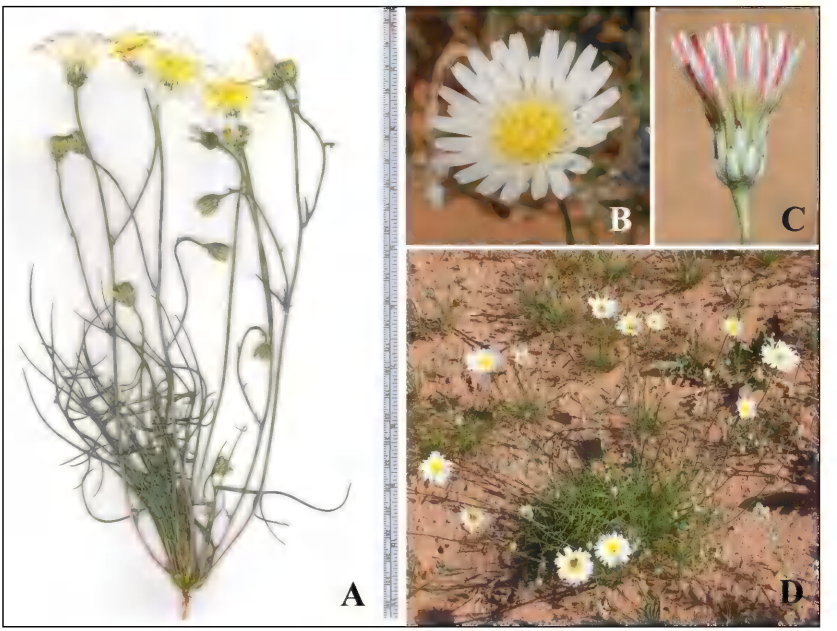

Figure 72. *Malacothrix glabrata*. (A) Hwy 86 roadside, E of Kitt Peak Road, 11 Apr 2010. (B & D) Dunes 20 mi S of Sonoyta, Sonora, on Mex Hwy 8, 27 Mar 2010. (C) Puerto Peñasco, Sonora, 17 Feb 2008.

Herbage slightly woolly when young, becoming glabrate, often semi-succulent. Leaves mostly in a basal rosette, 6–18 cm long, pinnatifid with linear to thread-like segments, usually withering before flowering. Flowering stems simple, or few- to sometimes many-branched, 10–45+ cm tall, mostly with a few leaves below. Involucres 2.5–3 cm wide; phyllaries densely to sparsely woolly on outer surfaces, the larger phyllaries ca. 20+ in number, (8) 9–14 mm long, green with white, membranous margins. Flower heads on long peduncles, nodding in bud; closing at night, opening at about 7 a.m. Heads to 5 cm in diameter, cream white to pale yellow with a darker yellow

center. Ligules 12–16 (25) mm, the outer ligules often with a pale reddish mid-stripe below. Receptacle bristly. Achenes 2–3 mm long, with 1 or few pappus bristles and with or without tooth-like scales.

Widespread and common; dunes, plains, washes, bajadas, canyons, and sometimes on rocky hills and mesas.

Northwestern Sonora and Baja California Sur to Oregon, Idaho, Utah, and Arizona.

OP: Alamo Canyon, 2500 ft, *Nichol 14 Mar 1939*. 7.2 mi NW of Visitor Center on Puerto Blanco Drive, 10 May 1979, *Bowers 1713*. Aguajita, 3 Mar 1992, *Felger 92-115*. NE of Bates Mts, 23 Mar 2003, *Rutman 2003-399*.

CP: Papago Well, *Crooks 31 Mar 1937*. W side of S end of Sierra Pinta, *Monson 20 Mar 1958*. Pinacate Lava, 29 Mar 1985, *McLaughlin 2983*. San Cristobal Wash, 11 Apr 1992, *Harlan 162*. Pinta Sands, 11 Apr 1993, *Felger 93-401*.

Malacothrix sonorae W.S. Davis & P.H. Raven
Sonoran desert-dandelion. Figure 73.

Figure 73. *Malacothrix sonorae*. Bull Pasture Trail near Estes Wash, 6 Apr 2010.

Delicate plants often 10–20+ cm tall. Basal rosette leaves 2.5–5 cm long, lanceolate to oblanceolate, with broad, coarse teeth or toothed segments; stem leaves reduced. Flower heads 1–1.5 cm wide, on branched and slender-stemmed inflorescences, the ligules white (or maybe yellowish). Phyllaries 8–14 or more, 7–9 mm long, the accessory bracts ca. 8–10 in number, less than ⅓ as long as the longer phyllaries. Receptacle not bristly. Achenes slender, 1.8–2 mm long, with 15 ribs, the uppermost part of the achene smooth, the pappus of 1–2 bristles plus persistent teeth.

Washes, canyon bottoms, and rocky slopes in the Ajo and Santa Rosa mountains, often in shaded niches; seldom common.

Southern Arizona from the Ajo Mountains to eastern Pima County, and Sonora southward to the vicinity of Hermosillo and the northern margin of the Guaymas Region.

OP: Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 554*. Ajo Loop Drive, 4 May 1978, *Bowers 1306* (ORPI). Sierra Santa Rosa, canyon bottom, 12 Mar 2003, *Felger 03-317*. Alamo Canyon, 29 Mar 2003, *Felger 03-418*.

CP: Salazaria Wash, 32°11'20"N, 113°43'W, 12 Apr 1992, *Harlan 220*.

Microseris linearifolia, see **Uropappus lindleyi**

Monoptilon

Two species; *Monoptilon bellidiforme* occurs in Arizona, California, Nevada, and Utah. Astereae.

Monoptilon bellioides (A. Gray) H.M. Hall

Mojave desert-star. Figure 74.

Low-growing spring ephemerals mostly 1.5–25 cm wide, with coarse, white hairs and sessile glands, especially on the phyllaries. Early leaves in a basal rosette, the stem leaves alternate, linear-spatulate, often 7–12 mm long, closely spaced below the flower heads, and few and widely spaced along stems, reaching 20–35 mm long on robust plants. Flower heads showy, solitary on stem tips, 1 or more per plant, often obscuring the leaves, mostly 1.2–1.7 (2) cm wide, showy, the rays 6–10 mm long, white to lavender, the disk yellow; flower heads "closing" at night, the rays inrolling. Phyllaries 5–6 mm long, narrowly oblanceolate to elliptic, green with membranous margins and red acuminate tips, the inner phyllaries partially enclosing the ray achenes. Achenes 1.5 mm long, obovate, brown, and hairy; pappus of golden-brown scales and bristles 2–2.5 mm long.

Seasonally common and widespread. Often producing spectacular displays on otherwise nearly barren gravelly flats and desert pavements; sandy to rocky soils, washes, bajadas, *Larrea* flats, mesas, and lower slopes. Sometimes only a few cm tall with a single flower head, but in sandy soils of canyon bottoms in favorable seasons sometimes forming sprawling plants to 50 cm across.

Northwestern Sonora, northeastern Baja California, western and southern Arizona, southeastern California, and southern Nevada.

OP: Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939*. W base of Ajo Mts, 2500 ft, 14 Mar 1941, *Benson 10625*. Dripping Springs, *Hesselberg 10 Apr 1966*. N of junction of Bates Well and Cabeza Prieta roads, 30 Mar 1978, *Bowers 1153*. Aguajita, wash, *Beale 8 Apr 1988* (ORPI).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3911* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-430*. 2 mi NW of Christmas Pass, *Rutman & Tibbitts 18 Feb 2002*.

TA: N of Tinajas Altas Pass, *Halse 31 Mar 1973*. Tinajas Altas Canyon, 19 Mar 1998, *Felger*, observation.

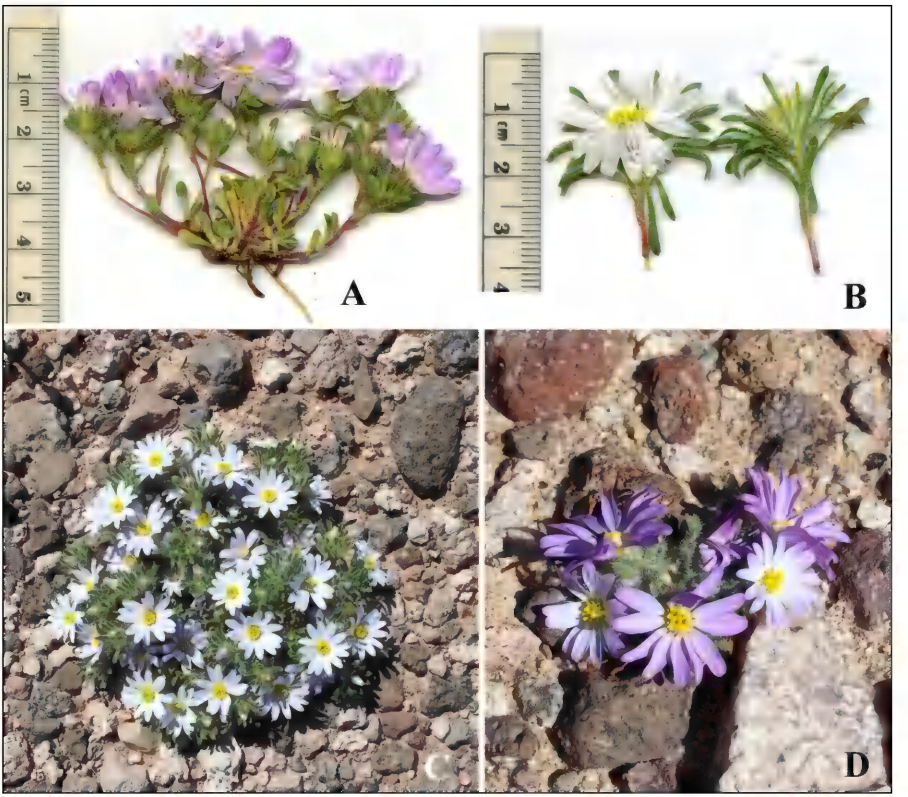

Figure 74. *Monoptilon bellioides*. (A) Kuakatch Wash near Kuakatch Village, 11 Mar 2015. (B) Midway Wash, 28 Feb 2015. (C) W side of Lookout Mountain, Maricopa Co., 12 Mar 2014. (D) Kuakatch Wash near Hwy 85, 3 Mar 2014.

***Oncosiphon**

Native to southern Africa, widely introduced; 8 species. Anthemideae.

***Oncosiphon piluliferum** (Linnaeus f.) Källersjö
[*Matricaria globifera* (Thunberg) Frenzl ex Harvey]
Globe chamomile, stinknet; *manzanilla*. Figure 75.

Small, aromatic spring ephemerals. Flowers heads rounded, of more than 100 minute, yellow disk florets.

Known in the flora area from several records. Perhaps established in San Cristobal Wash in Cabeza Prieta.

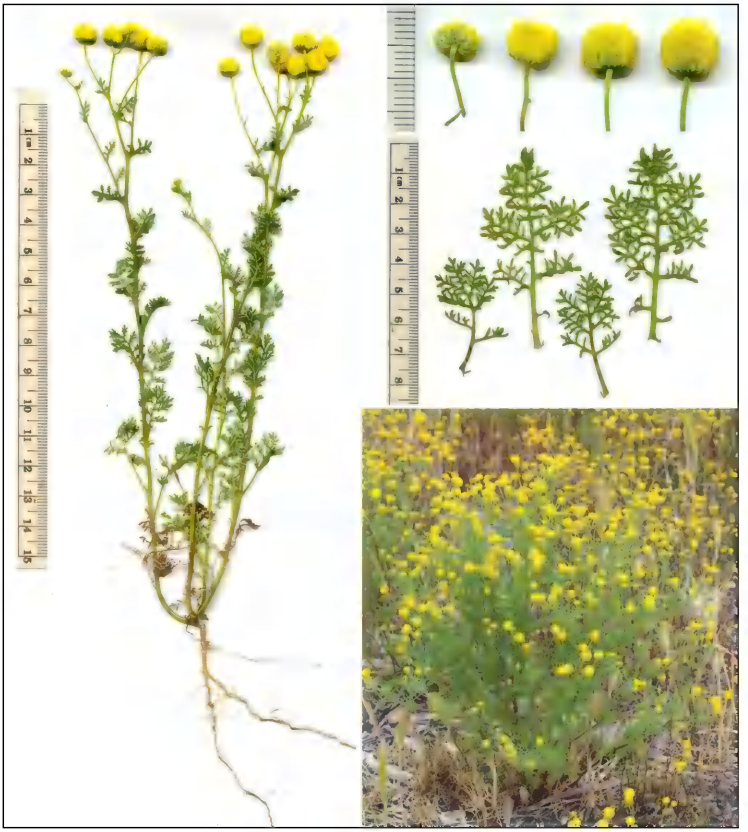

Figure 75. *Oncosiphon piluliferum*. Roadside N of the Gila River, Hwy 85, Maricopa Co., 28 Feb 2015.

Occasionally encountered elsewhere in Arizona in the Sonoran Desert but seldom in natural areas. Also in California and native to South Africa. This species was first noted in North America in 1981 in southern California and the Phoenix region and it rapidly became locally common.

OP: Cherioni Wash & Hwy 85, several plants, disturbed road shoulder on soils imported from vicinity of Why (a few plants also at another construction site 2–3 mi N of Visitor Center), *Rutman 15 Apr 2005*.
CP: San Cristobal Wash, 32°06'N, 113°07'W, 11 Apr 1992, *Harlan 165*.

Packera – Ragwort

Subtropical to arctic region in North America; 64 species. This genus is segregated from *Senecio*. Heliantheae, Senecioneae.

Packera "contains species that have traditionally been referred to as the 'aureoid senecios,' an informal group first recognized by Asa Gray. Base chromosome numbers of × = 22 or 23 and a suite of morphologic characters have been used in circumscription of *Packera*. Studies involving

molecular data and palynological analysis lend additional support for recognition of the genus" (Tock 2006). Yet the distinctions can be daunting.

Packera quercetorum (Greene) C. Jeffrey
[*Senecio quercetorum* Greene]
Oak Creek ragwort. Figure 76.

Herbaceous perennials to 50 cm tall; often bluish green, glabrous or tomentose basally and in leaf axils. Stems usually purple tinged, especially below. Largest leaves at base and in basal rosette, to 15 cm long, petioled, the blades obovate or pinnately lobed, the terminal lobe largest and with toothed margins; upper stem leaves reduced; lower leaf surface often reddish purple. Flowers heads many, on branched inflorescences held well above the leaves, with bright yellow ray and disk florets, the rays 6–10 mm long; ray and disk florets fertile. Phyllaries green, equal and relatively thick, glabrous or the tips pubescent. Achenes 1.5–4 mm long, cylindrical and ribbed, with deciduous, filiform, white pappus bristles. Flowering March to May.

Figure 76. *Packera quercetorum*. (A) Arch Canyon below Mount Ajo, 29 Mar 2015, photo by Peter Holm. (B) Sedona, Coconino Co., 24 Apr 2004, photo by Max Licher.

Ajo Mountains in canyons and higher elevations, especially shaded north-facing slopes. This is an isolated population, and the only one for the Sonoran Desert and Pima County.

Southwestern New Mexico and widespread in Arizona in non-desert regions and into pine forests.

OP: Alamo Canyon, *Nichol 4 May 1939*. Side canyon of Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 547*. Boulder Canyon, 2800 ft, 3 May 1978, *Bowers 1284*. Trail from The Cones to Mount Ajo, 3940 ft 10 Apr 2005, *Felger 05-253*.

Palafoxia

Southern United States and Mexico; 12 species. Heliantheae, Chaenactidinae.

Palafoxia arida B.L. Turner & M.I. Morris var. **arida**
Spanish needles. Figure 77.

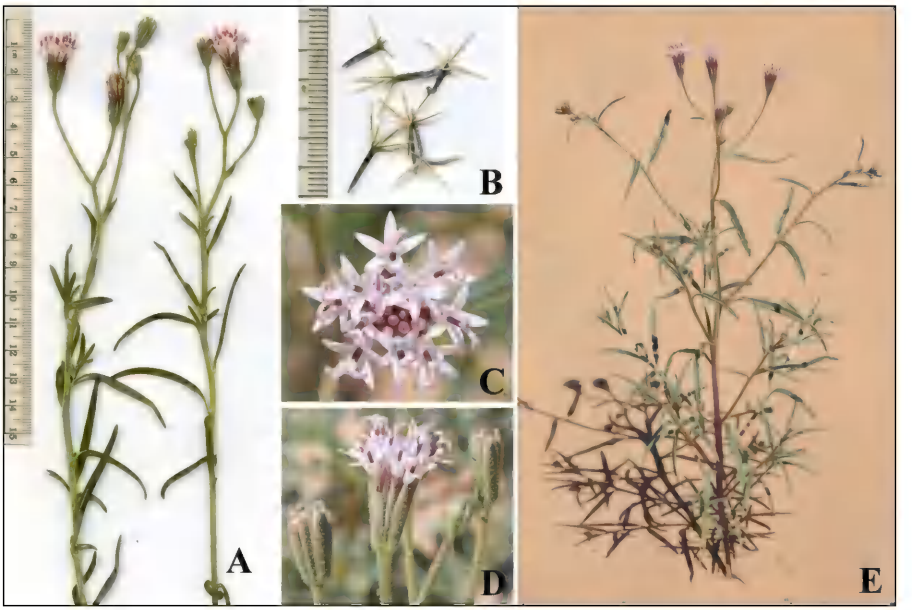

Figure 77. *Palafoxia arida* var. *arida*. Puerto Peñasco, Sonora: (A) 19 Feb 2015; (E) 17 Feb 2008. (B) Dunes near Maya Palace, 25 mi E of Puerto Peñasco, Sonora, 20 Feb 2015. (C & D) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 16 Feb 2008.

Winter-spring ephemerals sometimes germinating and flowering with summer-fall rains. Plants usually erect, often 30–90 cm tall, with a single erect main axis or branched from above the middle, or sometimes many-branched and bushy when well watered; with coarse silvery hairs. Leaves at first opposite, otherwise alternate, 3–9 cm long, linear to linear-lanceolate, with forward-pointing hairs; margins entire. Flowering stems and phyllaries with glandular hairs. Flower heads cylindrical to narrowly turbinate, mostly 20–25 mm long, of disk florets only, the corollas and stigmas dull white to pale pink, the anthers dark purple. Phyllaries equal, in a single series. Achenes 7.5–12.3 mm long, narrowly obpyramidal, blackish, 4-angled, mostly densely pubescent with short white hairs or sometimes glabrous; pappus of papery scales.

Central part of Organ Pipe westward; widespread in Cabeza Prieta, most abundant on sandy soils including dunes.

Mojave and Sonoran deserts in southwestern United States and northwestern Mexico. In central Sonora, at about Hermosillo and Bahía Kino, *P. arida* grades into *P. linearis* (sensu Turner & Morris), which extends southward to Sinaloa, and a similar transition occurs on the Baja California Peninsula. Turner and Morris (1975: 79) differentiate *P. linearis* as "sprawling shrublets having linear leaves with round or obtuse apices" and restrict it to "coastal sand dunes of southern Baja California."

Plants from that region appear indistinguishable from those of coastal southwestern Sonora and Sinaloa.

OP: Puerto Blanco Drive, 10 mi by road W of Hwy 85, 11 Apr 1978, *Bowers 1226*. Aguajita, wash, 14 Sep 1988, *Felger 88-406*.

CP: Tule Mts, 26 mi W of Papago Well, 15 Apr 1941, *Benson 10787 & Darrow*. O'Neill's Grave, 11 Apr 1992, *Harlan 182*. Pinta Sands: 10 Apr 1978, *Reeves 6789* (ASU); 15 Sep 1992, *Felger 92-781*.

TA: Butler Mts, sand dune, *Van Devender 27 Mar 1983*.

Parthenice

This genus has a single species. Heliantheae, Ambrosiinae.

Parthenice mollis A. Gray

Annual monsterwort. Figure 78.

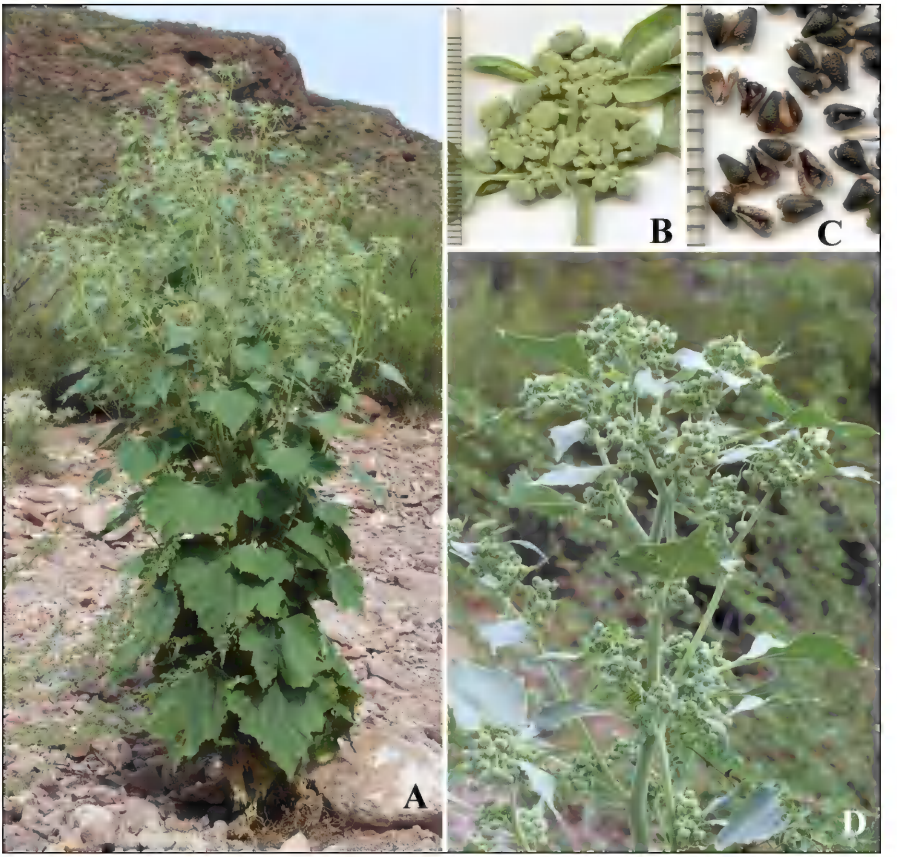

Figure 78. *Parthenice mollis*. Estes Wash near Ajo Mountain Drive: (A) Plant 2 m tall, 14 Aug 2013. Estes Wash, 0.5 mi S of Estes Canyon trailhead on Ajo Mountain Drive: (B & C) 26 Aug 2014; (D) 14 Aug 2013.

Robust warm-weather ephemerals, the stems erect, reaching 2 m tall, with dull gray-green herbage. Leaves alternate, petioled, the blades mostly 10–25 cm long and nearly as wide (exceptionally 36 cm wide), velvety pubescent, ovate to deltate, the margins coarsely and shallowly toothed. Flower heads many in open panicles, 5 mm wide, gray-green and inconspicuous with disk-like florets, the corollas yellowish. Ray florets minute, with achenes 2 mm long, obovate, the pappus minute or absent. Receptacle with bracts (palea) partially enclosing achenes and falling with them. Disk florets numerous, functionally staminate. Reproductive with summer rains.

Occasional in sandy-gravelly soils of washes and steep rocky slopes in Organ Pipe, mostly in the Ajo Mountains to higher elevations.

Arizona and northwestern Mexico.

OP: 12 mi N Visitor Center, 13 Jul 1962, *Ranzoni 176* (ORPI). Estes Canyon Picnic Area, 6 Nov 1977, *Bowers 961* (ORPI). Estes Wash, 706 m, 8 Aug 2003, *Rutman 20030808-4* (ARIZ, ASU). Slopes N of the saddle between Arch and Boulder canyons, 26 Oct 2003, *Rutman 20031026-13.*

Pectis – Chinchweed

Summer ephemerals in the flora area, also perennials elsewhere. Leaves opposite, narrow, sessile or essentially so, and with 1–several pairs of bristles or cilia near the base of the leaf. Flower heads with ray and disk florets. Achenes linear, club-shaped; pappus variable, sometimes reduced.

Western Hemisphere, the Galapagos Islands and Hawaii; 90 species. Heliantheae, Pectidinae.

Most species in the genus are pungently aromatic with essential oils imparting a lemon-like scent and have leaves and phyllaries dotted with conspicuous oil glands. However, two of the three species in the flora area are not aromatic, and have small, inconspicuous and selfing (autogamous) flowers. *Pectis* is rare among the Tageteae and composites in general in having C_4 rather than C_3 photosynthesis, providing an important adaptation to hot climates. Molecular studies show *Pectis* to be sister to, or encompassing, the genus *Porophyllum* or part thereof (Hansen 2012; Loockerman et al. 2003).

1. Plants pungently aromatic; flowers bright yellow and showy; ray florets 7–9…….. **Pectis papposa**
1. Plants not aromatic; flowers rather inconspicuous, dull yellow or purplish; rays florets 3–6.

2. Plants usually less than 5 cm tall, the internodes often shorter than the leaves; heads sessile, almost hidden among upper leaves; flowers yellow, the ray florets 3, the disk florets more than 3; achenes do not cling…….. **Pectis cylindrica**
2. Plants usually more than 10 cm tall, the internodes usually longer than the leaves; heads on slender peduncles at least 1 cm long; flowers purplish, the ray florets 4–6, the disk florets 1–3; achenes cling due to minute barbs…… **Pectis linifolia**

Pectis cylindrica (Fernald) Rydberg
[*P. prostrata* Cavanilles var. *cylindrica* Fernald]
Sonoran chinchweed; *hierba de chinche*. Figure 79.

Small, often mat-forming plants, the mats may be formed of many small, individual plants; not aromatic. Leaves (0.8) 1–2 (2.4) cm long, narrowly oblanceolate, narrowed to a winged petiole-like base with prominent bristles; midrib and margins of lower leaf surfaces thickened and light colored, the margins minutely toothed. Heads with 3 ray florets and 8–13 or fewer disk florets; the florets relatively inconspicuous, scarcely protruding from the involucre. Rays yellow, small and not obviously differentiated from the disk florets. Achenes 4–4.5 mm long, slender, blackish, with straight to slightly sinuous white hairs. Pappus of ray achenes with 2 scales; pappus of disk achenes with 5 scales. Self-fertile (autogamous), characterized by reduced, inconspicuous flowers and low pollen production (Keil 1975).

Seasonally abundant in dry mud of flooded playas including Pinta Playa and Las Playas in Cabeza Prieta. Also in similar habitats in nearby Sonora and eastward from Organ Pipe at Menager's Dam.

Southwestern Texas to Arizona and northern Mexico including the Baja California Peninsula.

CP: Pinta Playa, *Edwards 9 Oct 1977* (ASU). Las Playas, 28 Nov 2001, *Felger 01-566*.

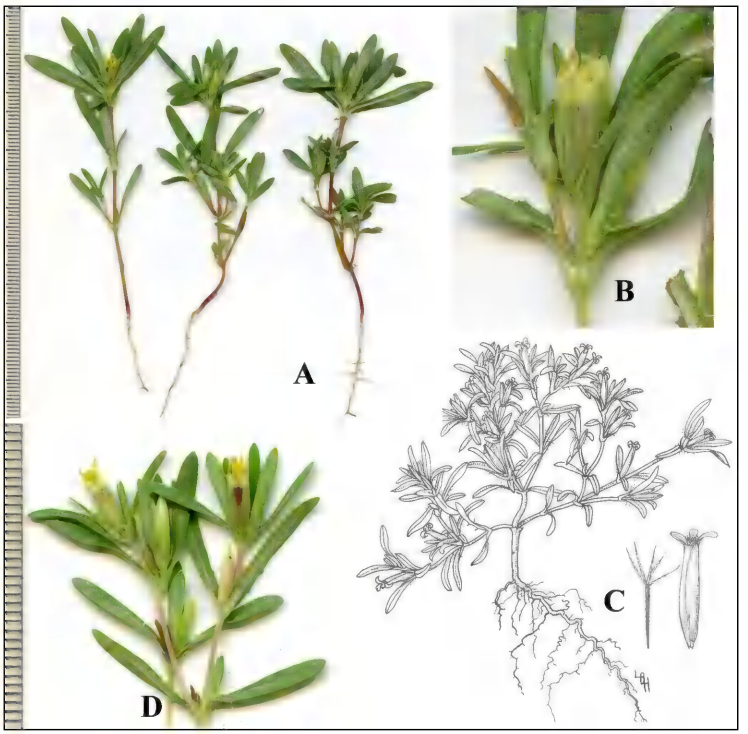

Figure 79. *Pectis cylindrica*. (A, B & D) Roadside of Hwy 86, east of Why, 1 Aug 2014. (C) By Lucretia Breazeale Hamilton.

Pectis linifolia Linnaeus var. **linifolia**
[*P. linifolia* var. *marginalis* Fernald. *P. punctata* Jacquin]
Figure 80.

Plants gland-dotted but not aromatic, to about 25 cm tall, the stems very slender with forked branching. Leaves linear, to 3 cm long; internodes usually longer than the leaves. Phyllaries often purplish. Heads of 5 small ray florets and 1–3 disk florets, rather inconspicuous, self-fertile (autogamous) as evidenced by low number of florets per head, reduction in ray size (1 mm long), and small anthers (less than 1 mm long) with low pollen production. Achenes ca. 5 mm long, the pappus of 2 or 3 spreading awns.

Figure 80. *Pectis linifolia* var. *linifolia*. (A) Base of cliff, Arch Canyon, 13 Sep 2013. (B & C) Wash crossing N end of Ajo Mountain Drive, draining the Diablo Mts, 26 Aug 2014. (D) Bull Pasture Trail, against N-facing cliff, 25 Sep 2013.

Scattered in the Ajo Mountains in shaded microsites.

Arizona to South America, West Indies, and Pacific Islands. The geographic distribution is one of disjunctions. It has "adaptations that appear to favor animal dispersal, with birds being the most likely carriers. The achenes of these plants characteristically bear stout, divaricately spreading awns that project from fruiting heads. . . . The achenes readily cling to fabrics and presumably equally well to feathers. The plants commonly grow on open rocky coastal sites which in insular situations are favored by sea birds" (Keil 1978: 137). *Pectis linifolia* var. *linifolia* has the largest natural range of the genus. However, some of its distribution (the Galapagos and Hawaiian Islands) is probably due to recent introduction (Hansen 2012). Another variety is very limited in distribution.

OP: E Loop Road, 3.3 mi from Route 85, 24 Sep 1972, *Pinkava 9970* (ASU, DES). Estes Canyon at crossing of Ajo Mountain Drive, large wash in shade of trees and shrubs, $2n = 12$ (II), 2400 ft, 28 Aug 1976, *Keil K-11787* (ASU). Arch Canyon: *Wirt 13 Aug 1990*; Loose talus shaded microsite, 12 Sep 2013, *Rutman 20130912-18*. Bull Pasture Trail, about halfway up to Bull Pasture, 25 Sep 2013, *Rutman 20130925-10*.

Pectis papposa Harvey & A. Gray var. **papposa**
Desert chinchweed; *manzanilla del coyote*; ban manzani:ya. Figure 81.

Summer-fall ephemerals; pungently aromatic; highly variable in size, sometimes to 30 cm across, usually much smaller and occasionally reproducing when only 1.5 cm tall. Leaves 1.5–4 cm long, linear with prominent bristles on a winged petiole-like base. Heads showy, flowers bright yellow. Phyllaries 3.5–4 mm long, oblong, green with a firm midrib. Rays conspicuous, 6–8; ray achene pappus absent or reduced to a crown of minute scales. Disk pappus of many plumose bristles, conspicuous but shorter than the corollas, or the disk pappus on some plants reduced to a crown of minute scales or absent. Achenes 2.8–3.5 mm long, columnar, blackish, with appressed, white (to brownish) hairs, the tips uniquely curled inward with a bulbous-tip (occasionally the hairs few and straight).

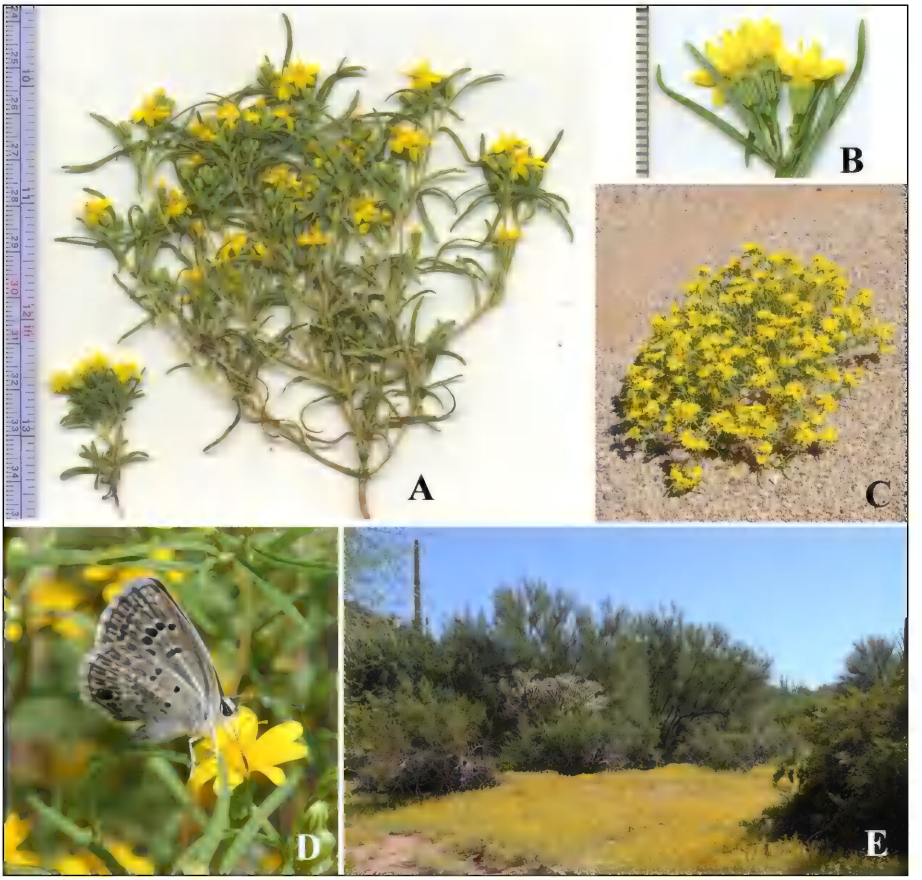

Figure 81. *Pectis papposa* var. *papposa*. (A) N boundary of Organ Pipe near Hwy 85, 17 Sep 2013. (B) Why, 31 Jul 2014. (C) Bates Well Road, W of Bates Well, 30 Sep 2006. (D) Reakirt's Blue (*Echinargus isola*), roadside of Hwy 86, E of Why, 20 Aug 2006. (E) Knucklehead Wash, base of Childs Mountain, 5 Sep 2014.

One of the most abundant and widespread summer-fall wildflowers in the region; sandy to rocky soils, dunes, washes, plains, slopes, and around waterholes.

This species occurs in all four North American deserts and often colors the landscape yellow. Two varieties: var. *papposa* occurs in the Great Basin, Mojave, and Sonoran Deserts in southwestern United States and northwestern Mexico. Variety *grandis* Keil primarily occurs in the Chihuahuan Desert.

The Seris, Pimas, Zunis and others have used the plant medicinally and as a spice (e.g., Moerman 1998). Leaves and phyllaries in *Pectis* species are dotted with embedded pellucid glands (oil glands). In *P. papposa* and others the liquid within the schizogenous cavities includes a mixture of strongly scented monoterpenes, often described as "lemon-scented" when citral is the predominant compound and "spicy-scented" when other oils are predominant. The essential oil is rich in cumaldehyde and carvone, and potentially as a commercial source of these fragrant aldehydes, now obtained from cumin, caraway, and dill seed oils (e.g., Bradley & Haagen-Smit 1949).

OP: Near Alamo Canyon, *Hesselberg 15 Oct 1966*. Cuerda de Leña wash at N boundary, 13 Sep 1978, *Bowers 1535*. Quitobaquito, 10 Nov 1987, *Felger 87-304*.

CP: Jose Juan Represo, 12 Jun 1992, *Felger 92-557*. Daniels Arroyo at Charlie Bell Road, 18 Aug 1992, *Felger 92-669*. Camino del Diablo 1 mi E of Namer's Grave, 15 Sep 1992, *Felger 92-768*.

TA: Coyote Wash at Camino del Diablo, 25 Oct 2004, *Felger 04-66*. Coyote Water, 25 Oct 2004, *Felger 04-56*.

Perityle – Rock daisy

Ephemerals or perennial herbs. Leaves petioled, alternate or opposite below. Flower heads with ray and disk florets or without rays. Achenes black, flattened, the margins thickened, white, and edged in ciliate hairs; pappus with small scales or not, and also 1 or 2 often unequal, minutely barbed awns or awns sometimes absent.

North America, especially southwestern United States, and South America; 66 species. Heliantheae, Peritylinae.

1. Perennials; flower heads of yellow-gold disk florets, without rays; Ajo Mountains.
…… **Perityle ajoensis**
1. Cool-season ephemerals; flower heads with white rays and a yellow disk; widespread.
…… **Perityle emoryi**

Perityle ajoensis T.K. Todsen, J. Arizona Acad. Sci. 9: 35, 1974.
Ajo rock-daisy. Figure 82.

Perennial herbs (dwarf shrubs) 20–70 cm tall, often globose with upright to spreading stems. Leaves opposite below, alternate above, the foliage somewhat sparse, minutely and partially woolly and also with short glandular hairs; leaf blades ovate to broadly triangular (deltate) or nearly circular in outline, 5–12 mm long and about as wide, the petioles about as long as the blades. Flower heads at the tips of twigs, single or in small clusters, the heads 8–10 mm long, with about 20–30 yellow-gold disk florets and no rays. Achenes narrow, 3–3.5 mm long, flattened, the body blackish at maturity with thickened yellowish-white margins; pappus with 1 or 2 stout bristles (awns) 2–3 mm long, or the bristles sometimes absent. Flowering at least in October.

This species is known only from the Ajo and Diablo mountains. It may have been present at least 22,000 years ago (see *Perityle* sp. below). *Perityle ajoensis* is highly localized and often grows out of rock crevices at elevations mostly above 2700 ft. The habitat is very patchy, and patches are

generally small (can be measured in square meters). Some patches have a few dozen plants, some have just a few. Most of the patches seem to have water percolating very slowly through the bedrock. The rock is not wet but you can see mineral deposits indicating percolation. Then again, Marc Baker found a large boulder with *P. ajoensis*, and this could not have had water percolation. The habitat patches are all on north-facing cliffs or places like overhangs where the plants are shaded. This species probably will become extinct due to climate change.

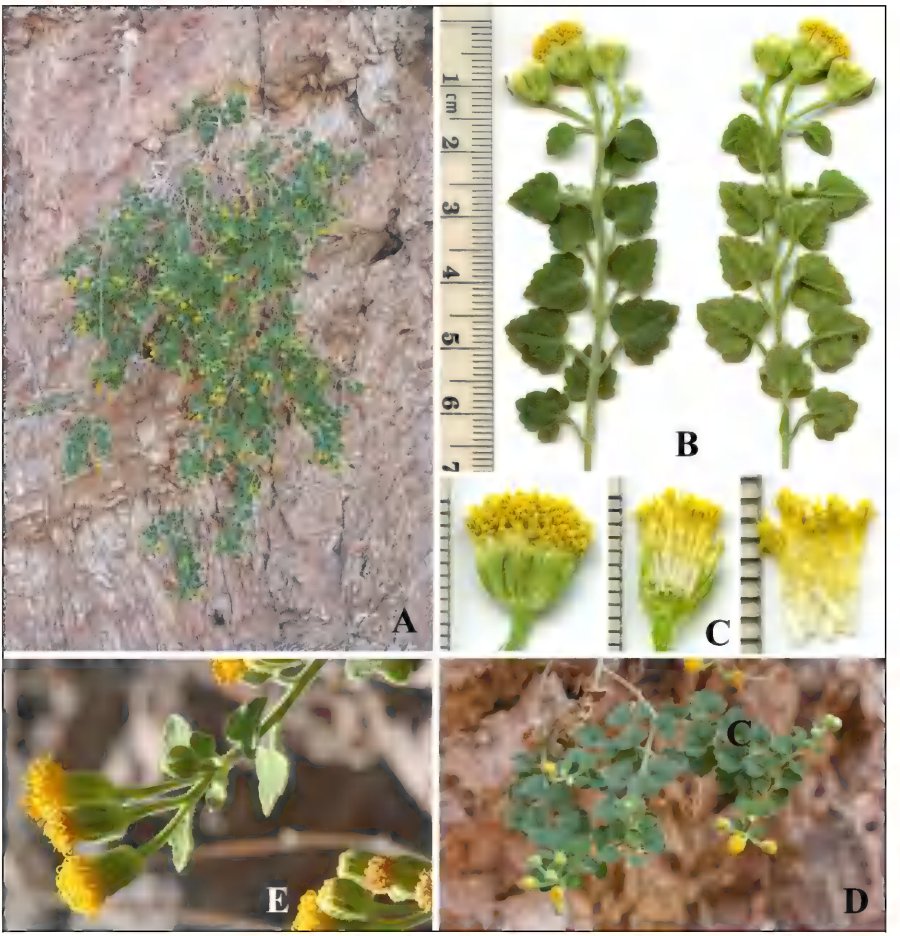

Figure 82. *Perityle ajoensis*. Arch Canyon: (A) 16 Sep 2006; (B & C) 12 Sep 2014. (D) Boulder Canyon, 16 Sep 2006. (E) N-facing cliff, trail to Mt Ajo, 15 Sep 2008.

OP: Bull Pasture Trail, 22 Oct 1972, *Todsen 2292* (holotype, NY; isotypes: ARIZ, ORPI). Estes Canyon, *Henry 6 Nov 1977*. Boulder Canyon, *n* = 17, 13 Oct 1988, *Baker 7643* (ASU, ORPI). Arch Canyon, 2 Dec 1990, *Felger 90-525*. Near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-337* (ORPI). Diablo Mts, 807 m, rooted in N-facing cliff, 4 plants (all in flower) at this site, 22 Sep 2003, *Rutman 20030922-20*.

Perityle emoryi Torrey
Desert rock-daisy. Figure 83.

Cool-weather ephemerals, 5–60 cm tall, sometimes semi-succulent when well watered; bearing sessile and stalked glands and sparse non-glandular hairs, or glabrate with age. Leaves mostly alternate, 1.5–6 (8+) cm long, the blades about as wide as long, coarsely toothed to palmately lobed, the lobes also toothed. Phyllaries 3.5–5.5 mm, green, oblong-ovate to obovate, ribbed, the margins ciliate. Ray corollas white, often 4–4.5 mm long, the disk florets yellow; disk and ray corollas densely glandular. Achenes 2.5–3.1 mm long, flat, blackish, the margins thin (not calloused), with a border of short, white hairs. Pappus of small scales and a single stout bristle or the bristle absent. (About one third of the specimens from the flora area lack pappus bristles; there is no discernible pattern to the variation.)

Figure 83. *Perityle emoryi*. Estes Canyon: (A) 2 Mar 2008; (C) 15 Mar 2008. (B & D) Alamo Canyon, 26 Feb 2014.

One of the most widespread winter-spring wildflowers in the region; sandy to rocky soils, washes, plains, and slopes. It was in the Puerto Blanco Mountains more than 2400 years ago and at Tinajas Altas more than 11,000 years ago.

Sonora and Baja California Sur to southern California, southern Nevada, southwestern Utah, and western Arizona, and disjunct in Peru and Chile.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939*. Red Tanks Canyon, 8 Apr 1941, *McDougall 50*. Bates Well, *Tinkham 22 Apr 1942*. Aguajita, 19 Jun 1989, *Felger 89-236*. Alamo Canyon, *Rutman 5 Mar 1995* (ORPI). †Puerto Blanco Mts, achenes, 2160 & 2340 ybp.

CP: 7 mi E of Papago Well, *Harbison 5 Dec 1939* (SD). Charlie Bell Pass, 3 Apr 1992, *Whipple 3912*. O'Neil's Grave, 11 Apr 1992, *Steinmann 186-C*. Cabeza Prieta Peak, 24 Mar 1995, *Yeatts 3664*.

TA: Base Tinajas Altas, 29 Mar 1930, *Kearney 6562 & Harrison*. Tinajas Altas Mts at Mexico border, 18 Mar 1998, *Felger*, observation. Coyote Water, 25 Oct 2004, *Felger 04-57*. 2.5 mi SE of Tinajas Altas, 22 Nov 2008, *Felger 08-209*. †Tinajas Altas, achenes, 9230 & 10,950 ybp.

††Perityle sp.

The Montezuma's Head midden site of this unidentified *Perityle* is similar to the present-day, rocky habitats of *P. ajoensis*.

OP: †Alamo Canyon, achenes, 8130 & 8590 ybp. †Montezuma's Head, leaves, achenes, 13,500 to 21,840 ybp (3 samples).

Peucephyllum

This genus has a single species. Heliantheae, Chaenactidinae.

Peucephyllum schottii A. Gray

Desert fir, pygmy cedar; *romero del desierto*. Figure 84.

Woody shrubs 1–2+ m tall, resembling a small conifer, with woody, twisted trunks and branches, and shredding bark. Herbage conspicuously resinous with crowded glands glistening golden when fresh. Leaves alternate, essentially evergreen, mostly 7–30 × 0.8–1 mm, crowded at ends of twigs, sessile, linear-filiform, terete or nearly so, and bright green. Flower heads 10–15 mm long, solitary at stem tips, with disk florets only, fragrant, pale yellow-green, the corolla lobes and upper tube becoming reddish purple with age. Achenes 2.5–3 mm long, the surfaces nearly to wholly obscured by a dense covering of white hairs. Pappus of many scales and slender white bristles. Flowering January–May, and probably in fall.

Rocky slopes of volcanic and granite ranges in the western part of Cabeza Prieta and in the Tinajas Altas Region, often more common at higher elevations. It has been in the Tinajas Altas Region for at least 15,700 years.

Extremely arid regions of the Sonoran and Mojave deserts in southwestern United States and northwestern Mexico.

CP: Tule Tank, Cabeza Prieta Mts, 15 Apr 1941, *Benson 10799*. Ridgetop, SE edge of A-1 Basin, Cabeza Prieta Mts, 11 Mar 1984, *Hodgson 2752* (DES). Ridge E of Tule Tank, 23 Mar 1998, *Telewski 512*. Eagle Tank, 13 Jun 1992, *Felger*, observation.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. S of Tinajas Altas, N-facing slope, 8 ft tall, 7–8 ft wide, 18 Apr 1983, *Hodgson 2096* (DES). †Butler Mts, achenes, 740 to 11,060 ybp (5 samples). †Tinajas Altas, leaves, involucres, achenes, 1230 to 15,680 ybp (6 samples).

Figure 84. *Peucephyllum schottii*. Near Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009.

Pleurocoronis

Small shrubs or subshrubs, often globose, 0.8–1 m across, much branched, the stems slender and brittle. Leaves opposite below, alternate above, petioled, tardily drought deciduous. Inflorescences of loose terminal clusters of several or more heads; heads many flowered, with white to pale yellow disk florets with purple stigmas. Corolla tube long and slender, the lobes minute; style branches club-shaped and conspicuously exserted. Involucres of an inner series of larger phyllaries and an outer series of smaller, graduated phyllaries. Achenes narrowly obpyramidal and glandular, the pappus of barbellate bristles and membranous scales. Growth and flowering response non-seasonal.

The genus has 3 species including *Pleurocoronis gentryi* endemic to Baja California Sur. Eupatorieae.

The two intergrading species in the flora area mostly grow in rock crevices on steep, often north-facing granitic and volcanic cliffs, canyon walls, and rock slopes. *Pleurocoronis* has been in the Tinajas Altas Region for at least 15,700 years.

1. Leaf blades conspicuous and about as wide as long..... **Pleurocoronis laphamioides**
1. Leaf blades often much reduced and longer than wide..... **Pleurocoronis pluriseta**

Pleurocoronis laphamioides (Rose) R.M. King & H. Robinson
[*Hofmeisteria laphamioides* Rose]. Figure 85.

Differing from *P. pluriseta* by the much wider leaf blades and proportionally shorter petioles; leaf blades bright green and often semi-succulent, broadly ovate with several large teeth.

Organ Pipe mountains including the Ajo and Puerto Blanco mountains.

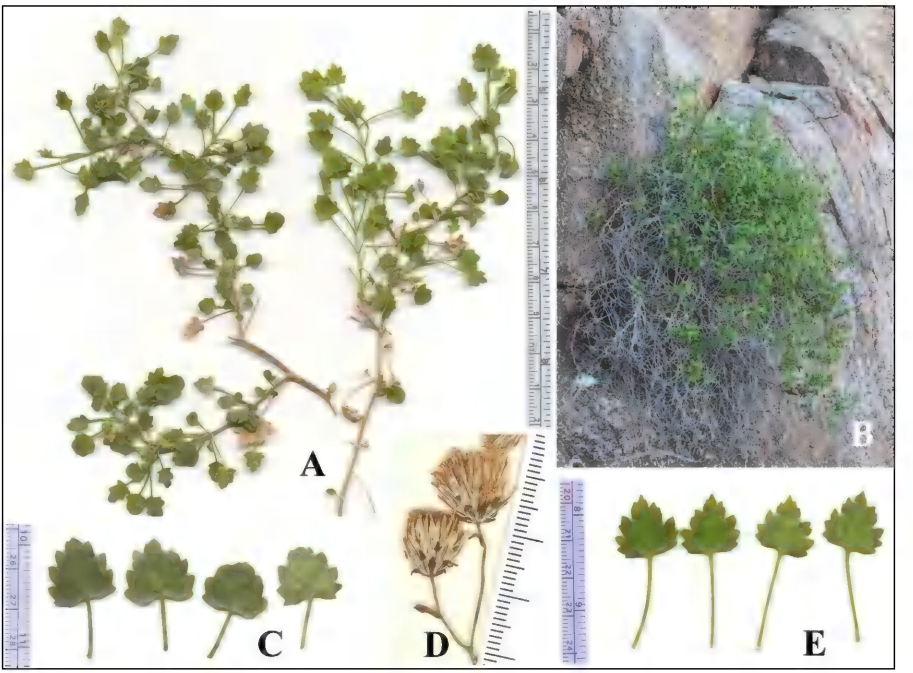

Figure 85. *Pleurocoronis laphamioides*. (A) Estes Canyon, 21 Sep 2008. (B & C) Granite cliff, Victoria Mine area, Puerto Blanco Mts, 23 Dec 2013. (D) Rocky hillside near Dripping Springs, Puerto Blanco Mts, *Lehto 3697*, 22 Mar 1964 (ASU). (E) Alamo Canyon, 9 Sep 2013.

Western Sonora, from east of the Pinacate region and adjacent Arizona southward to the Guaymas Region, Gulf of California islands, and Gulf Coast of both Baja California states.

There is a gradual (clinal) increase in leaf-blade size and relative width from drier to moister conditions from north to south (southwestern Arizona southward along the Sonora coast and similarly southward on the Baja California Peninsula). In the flora area there is a similar trend, with a transition across the flora area from the more arid west to the less arid east of narrower (*P. pluriseta*) to broader (*P. laphamioides*) leaves, and the variation is likewise continuous (clinal). However, the broader-leaved plants in the eastern part of Organ Pipe have conspicuously smaller leaves than *P. laphamioides* populations from farther south (central Sonora and Baja California Sur). Assigning the small but broad-leaved Organ Pipe populations to *P. laphamioides* rather than *P. pluriseta* is arbitrary and illustrates the problem of naming points on a continuum.

OP: Alamo Canyon: *Nichol 4 May 1939*. Dripping Springs, 18 Mar 1945, *Gould 3019*. Middle fork Alamo Canyon near crestline, 15 Mar 2003, *Rutman 2003-353* (ORPI). Bedrock outcrops NW of Kino Peak, 20 Mar 2005, *Rutman 20050320-38*.

Pleurocoronis pluriseta (A. Gray) R.M. King & H. Robinson
[*Hofmeisteria pluriseta* A. Gray]
Arrowleaf; *canutillo*. Figure 86.

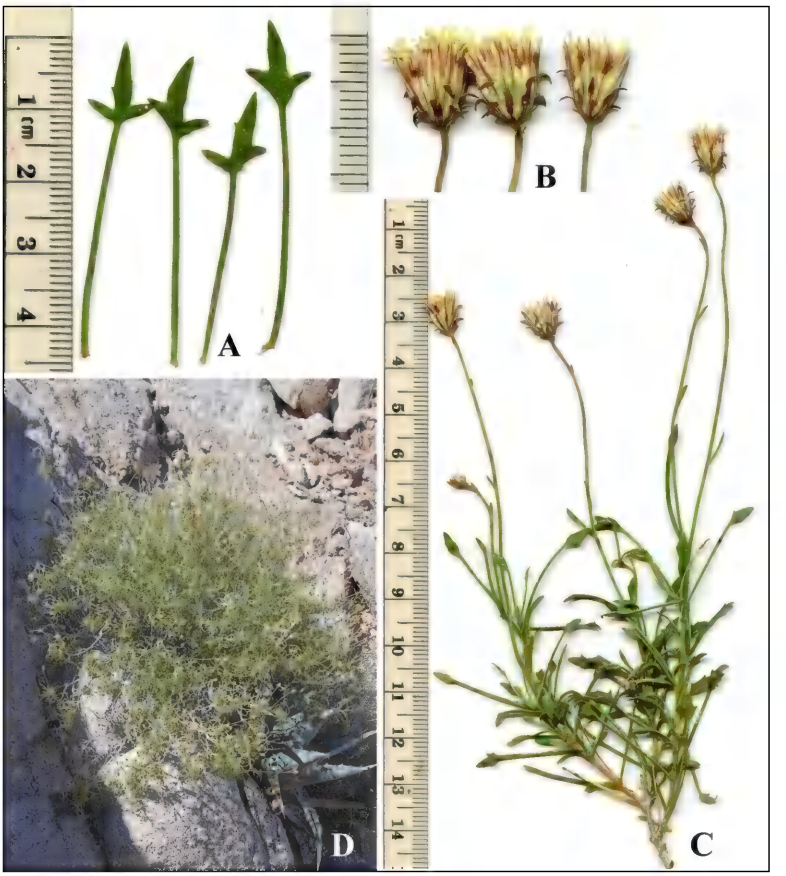

Figure 86. *Pleurocoronis pluriseta*. Steep granite slopes near Mex Hwy 2, Sierra Nina (Sierra del Águila), Sonora: (A & B) 7 Mar 2015; (C) 19 Mar 2015; (D) 17 Mar 2014.

Herbage densely pubescent with stalked, glandular hairs or relatively less pubescent when well watered or shaded. Leaves tardily drought deciduous; petioles 6–38 mm long, the blades mostly 5–15 (18) × 3.5–14 mm, ovate to lanceolate—narrowly arrow-shaped, usually with 1–3 pairs of large teeth on each margin. Leaf size and shape highly variable with moisture and shade. On hot exposed cliffs the leaves may consist of little more than the petioles, with the blades reduced to narrow spear-

shaped thickenings. Inner phyllaries 8–11 mm long, linear, thin, often green or purplish, with 3 prominent veins and thin, membranous white margins, the tip acuminate. Corollas, styles, stigmas, and anthers white to pale yellow, or the style branches and stigmas purple. Achenes 2.5–3 mm long, 4-angled, the surfaces minutely hairy with appressed hairs that spread when wet; pappus bristles 5–6.5 mm long, intergrading with outer small membranous scales, or the scales sometimes absent.

Widespread in Cabeza Prieta and Tinajas Altas, and perhaps in the western margin of Organ Pipe.

Northwestern Sonora, southwestern Arizona, Baja California, southeastern California, and southern Nevada.

CP: Tule Tank, 15 Apr 1941, *Benson 10804*. Tule Mts, 2 Feb 1992, *Felger 92-45*. Childs Mt, 2845 ft, 18 Aug 1992, *Felger 92-640*. Cabeza Prieta Peak, 2550 ft, 25 Mar 1995, *Yeats 3649*.
TA: Tinajas Altas Mts, 4 Mar 1927, *Belden 3604*. Base of Tinajas Altas, 29 Mar 1930, *Kearney 6564*. Tinajas Altas, 5 Dec 1935, *Goodding 2103*.

†**Pleurocoronis** sp.

The younger specimens are probably *P. pluriseta*.

TA: †Butler Mts, achenes, involucres, 740 to 11,250 ybp (7 samples). †Tinajas Altas, involucres, achenes, 4010 to 15,680 ybp (9 samples).

Pluchea

Widespread in both hemispheres; 50 species, although not monophyletic. Heliantheae, Plucheeae.

1. Annuals or herbaceous perennials, not woody..... **Pluchea odorata**
1. Shrubs with long, slender, woody branches..... **Pluchea sericea**

Pluchea odorata (Linnaeus) Cassini var. **odorata**
[*P. purpurascens* (Swartz) de Candolle]
Marsh fleabane, alkali camphor weed; *jara*. Figure 87.

Annual or perhaps perennial herbs 1–1.5 m tall from a thick, semi-fleshy root, sometimes with rhizomes. Herbage with sticky (viscid) as well as soft hairs, dotted with glands, and stinking. Leaves mostly 4–15 cm long, ovate to elliptic or lanceolate, toothed or entire or nearly so; lower leaves petioled, the upper leaves reduced and sessile. Phyllaries graduated, larger ones 4–5.5 mm long. Corollas and phyllaries pale to bright rose-lavender; rays absent; outer florets pistillate, numerous, in several series, the inner florets with sterile ovaries. Achenes 0.8–1.2 mm long, brown, columnar; pappus of slender, minutely barbed bristles. New growth generally emerging in spring or early summer; maturing and flowering August and September, the stems dying in late fall or early winter.

Locally common in wet soil around the Quitobaquito pond and ditches with flowing water, and nearby at Williams and other local springs.

Widespread in North American wetlands, often on alkaline and saline soils, to South America, western Africa, and Pacific Islands. A second, poorly defined sympatric variety occurs in eastern North America.

OP: Quitobaquito: 24 Nov 1955, *Anderson 4*; 23 Jul 1986, *Felger 86-204*. Williams Spring, *Van Devender 30 Aug 1978*.

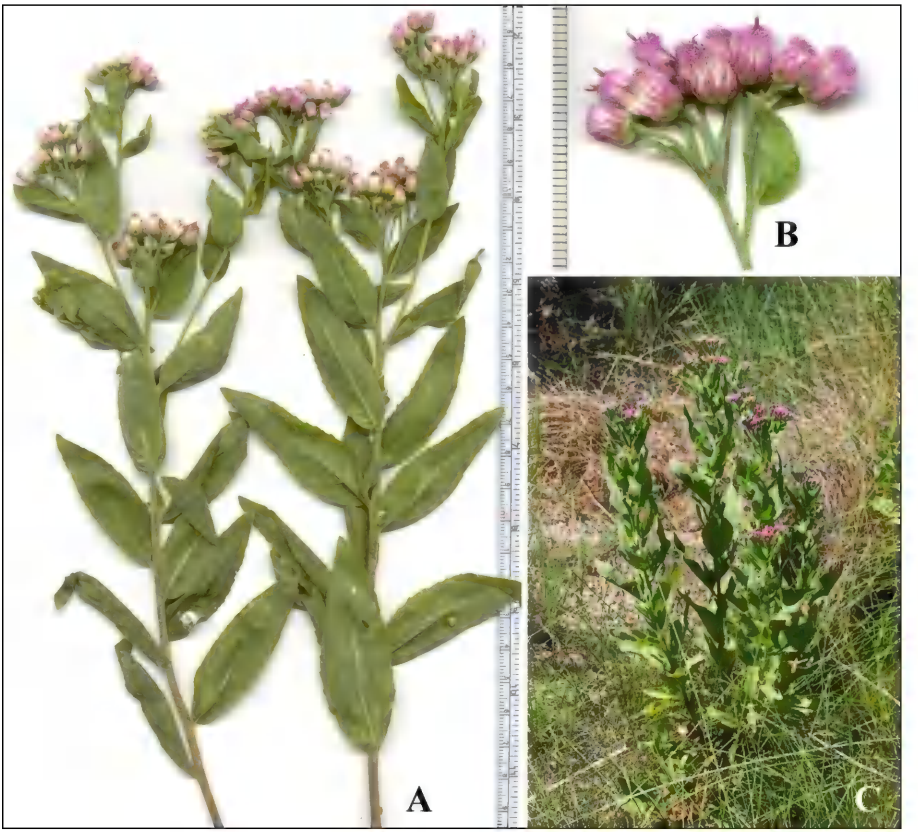

Figure 87. *Pluchea odorata* var. *odorata*. Quitobaquito: (A) 11 Sep 2008; (B) 23 Sep 2014; (C) 13 Sep 2006.

Pluchea sericea (Nuttall) Coville
[*Tessaria sericea* (Nuttall) Shinners]
Arrowweed; *cachanilla*; komagĭ 'u'us, 'u'us kokomadk. Figure 88.

Woody shrubs often 1.5–2.5+ m tall, densely colonial, spreading by rhizomes. Stems solid (not pithy; see *Baccharis salicifolia*), willow-like, erect, and densely leafy. Herbage densely silvery-hairy, not aromatic. Leaves (1) 1.5–4.5+ cm long, entire, sessile, mostly narrowly elliptic to lanceolate. Phyllaries often pinkish, graduated, the outer ones conspicuously broader, to 3 mm long, the longer inner ones 5–6 mm long. Flower heads of pinkish disk florets; outer florets pistillate, numerous, in several series, the inner florets functionally staminate with sterile ovaries. Achenes 1–1.3 mm long; pappus of slender, minutely barbed bristles widened (dilated) at apex, especially on central florets. Flowering at least March–June.

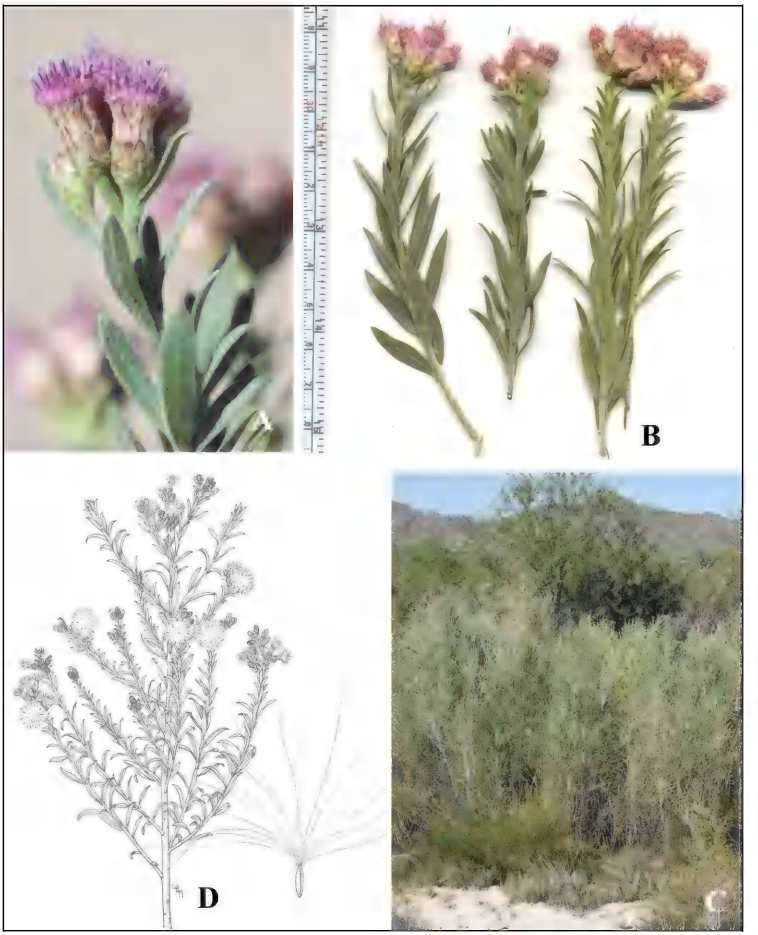

Figure 88. *Pluchea sericea*. (A & B) Below Gillespie Dam, Maricopa Co., 31 Mar 2013. (C) Quitobaquito, 10 Sep 2007. (D) By Lucretia Breazeale Hamilton.

Locally abundant in moist soil near Burro and Williams springs, and Quitobaquito at the springs and pond, and infrequent in nearby adjacent old fields and alkaline flats.

Southern California (most common in the desert, especially the Salton Trough) to southern Utah and western Texas, Baja California, Chihuahua, and northern Sonora. Arrowweed thrives in places of high water table and saline soils.

The long, leafy stems were used for round-house construction, and stems of the correct thickness were made into arrows for hunting bighorn sheep (Childs 1954; Philip Salcido in Felger et al. 1992). Arrowweed was widely used medicinally (Curtin 1949; Rea 1997; Russell 1908).

Placement of this distinctive species is problematic. John Pruski (pers. comm. to Felger, 7 Aug 2015), wrote "I would not use *Tessaria* in the USA nor introduce *Tessaria* into usage in USA. I use *Tessaria* only in tropics and as containing only 4 species. . . . Even though Guy Nesom in Flora of North America suggests *sericea* may fall outside of *Pluchea*, it is not a *Tessaria*."

OP: Burro Spring, 4 May 1978, *Bowers 1315*. Quitobaquito: *Nichol 28 Apr 1939*; *Van Devender 30 Aug 1978* (ORPI).

Porophyllum

Annuals and perennials. Western Hemisphere; 25 species. Heliantheae, Pectidinae.

Porophyllum gracile Bentham

Slender poreleaf; *odora, hierba del venado*. Figure 89.

Herbaceous perennials, glabrous and glaucous bluish-green with dark purplish, elongated and translucent oil glands and a pungent odor somewhat like that of marigolds (*Tagetes*), to which *Porophyllum* is related. Stems straight, slender, and brittle. Leaves opposite below, alternate above, 1.5–6 cm long, linear to thread-like, sparse and widely spaced, quickly drought deciduous, especially the larger ones. Flower heads cylindrical, solitary at ends of branchlets, of disk florets only; corollas white to pale purple with dark purple longitudinal lines. Phyllaries 10–17 mm long, linear-oblong, the margins membranous and rose-purple. Achenes 8–13 mm long, linear, blackish, moderately to densely covered with short, stiff, appressed hairs; pappus of many slender, pale brown barbellate bristles. Flowering at various seasons.

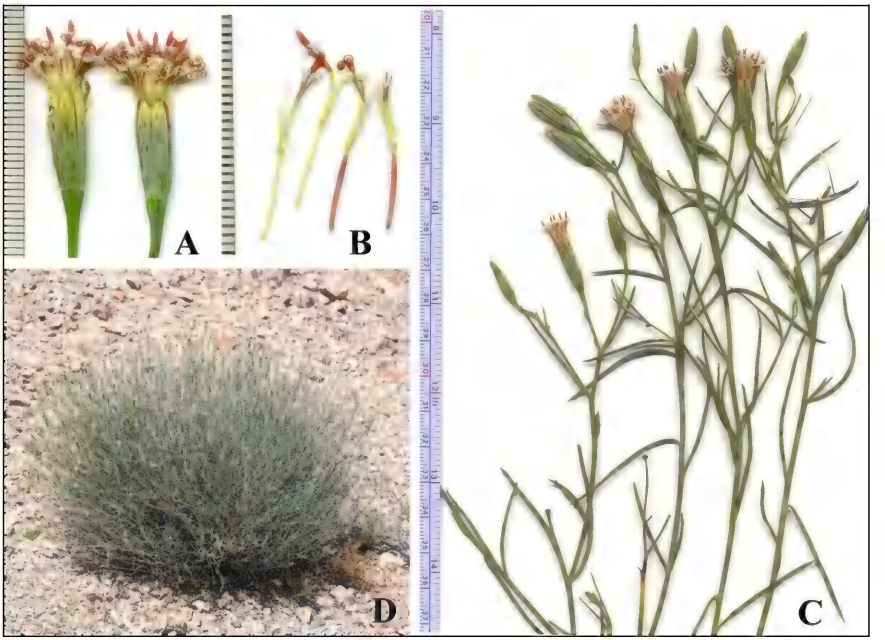

Figure 89. *Porophyllum gracile*. (A & B) N of Little Ajo Mts at Charley Bell Road, 5 Sep 2014. (C) Foothills of Black Mountain (SW of Ajo), 17 Sep 2013. (D) Victoria Mine area, Puerto Blanco Mts, 7 May 2006.

Widespread across the flora area but seldom very common; gravelly bajadas, and sometimes along larger washes, canyons, rocky slopes, and to high elevation in the Ajo Mountains. It has been in the Tinajas Altas Region for at least 8600 years.

Arizona, southeastern California, Nevada, western Texas, Utah, and Baja California, Baja California Sur, northwestern Sinaloa, and Sonora.

This aromatic plant was used by the Seris to aid childbirth and as a remedy for colds, toothache, and diarrhea—one woman said, "the thing it is not good for does not exist" (Felger & Moser 1985: 286).

OP: Cipriano Well, *Nichol 27 Apr 1939*. Bates Well, *Tinkham 23 Apr 1942*. Quitobaquito, 29 Mar 1988, *Felger 88-118*. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger 05-261*. Puerto Blanco Mts, Red Tanks Wash, 21 Sep 2013, *Rutman 20130921-6*.

CP: Tule Tank drainage, 23 Mar 1992, *Harlan 134*. Agua Dulce Pass, Christmas Pass, and Buckhorn Tank, 13 & 14 Jun 1992, *Felger*, observations. W of Chico Sunie Well, 2 Feb 2003, *Rutman 2003-19*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. 1.8 mi N of international border, E side Tinajas Altas, Mts, 22 Nov 2008, *Felger 08-214*. †Butler Mts, achenes, involucres, 740 to 8570 ybp (4 samples). †Tinajas Altas, involucres, achenes, 1230 to 8255 ybp (3 samples).

Prenanthella

This monotypic genus is related to *Rafinesquia* and *Stephanomeria*. Cichorieae.

Prenanthella exigua (A. Gray) Rydberg
[*Lygodesmia exigua* (A. Gray) A. Gray]
Brightwhite. Figure 90.

Figure 90. *Prenanthella exigua*. Charlie Bell Pass, Growler Mts, 16 Mar 2015.

Diminutive spring ephemerals, often 10–28 cm in height, with minute tack-shaped glandular hairs. Main axis well developed and paniculately branched above. Early leaves in a basal rosette or closely spaced on lower stem, 1.7–6 cm long, oblanceolate, pinnately and coarsely toothed to incised, often becoming red-green and withering as the upper branches develop; stem leaves reduced upward to subulate scales. Flower heads 5 mm long, of 3 or 4 ligulate (ray-like) florets, white with violet tips, the ligules 2.5–3 mm long; anthers white shading to violet at tips; stigmas violet with dark purple papillae; phyllaries 3 or 4, 4–5 mm long, plus 1 or 2 smaller accessory bracts. Achenes 3–3.7 mm long, columnar with a truncate apex, light brown, with 5 narrow grooves; pappus bristles in a dense tuft, persistent, white, minutely barbellate, fused at their bases, unequal in length, the longer ones 2.5–3 mm, or pappus bristles sometimes absent from 1 or more achenes in a head, the epappose achenes more persistent and slightly longer than the pappus-bearing achenes.

Widely scattered but usually localized across the flora area; mostly on rocky soils and sandy-gravelly wash margins, and hills and mountains.

Arizona to southeastern California, Colorado, Nevada, Utah, western Texas, northwestern Sonora, and rare in Baja California.

OP: Red Tanks, 8 Apr 1941, *McDougall 49*. Headquarters area, 10 Apr 1941, *McDougall 72*. Open rocky slopes, 0.5 mi NE of Quitobaquito, 18 Mar 1945, *Gould 2990*. 0.5 mi W of Bates Well Road, N boundary, 8 Mar 2003, *Rutman 2003-261* (ORPI).

CP: Agua Dulce Mts, 1200 ft, 14 Apr 1941, *Benson 10753*. Rocky slope 2 mi by road E of Tule Well, 28 Mar 1985, *Bowers 2996*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3920*.

TA: Tinajas Altas above the tinajas, 19 Mar 1998, *Felger 98-132*.

Psathyrotes

Southwest United States and northwest Mexico; 3 species. Heliantheae, Gaillardinea.

Psathyrotes ramosissima (Torrey) A. Gray

Desert velvet, turtleback. Figure 91.

Spring ephemerals or short-lived perennials; plants compact, much-branched and rounded, often 3.5–10 cm high, densely leafy and woolly-scurfy, and strongly scented, with a well-developed taproot. Leaves alternate, 1.7–4 cm long, petioled, the blades broadly ovate to kidney-shaped, often 1.2–2.3+ cm wide, thick, and velvety gray-green with deeply incised veins. Flower heads 8–9 mm long, with yellow disk florets, some with tips becoming red; peduncles well developed. Achenes hidden by dense "furry" hair, the achenes including pappus 4.5–6.5 mm long, the pappus of more than 100 bristles; achene hairs and pappus bristles bright iridescent copper color (dull yellow when immature or old and faded).

Localized near Tule Well and the north end of the Tinajas Altas Region; on volcanic desert pavement, cobble-rock bajadas, and on a steep granitic slope.

Deserts in western Arizona, northwestern Sonora, Baja California, California, Nevada, and Utah.

CP: 1 mi NW of Tule Well, 21 Mar 1992, *Yeatts 3246* (CAB).

TA: Camino del Diablo, E edge of Davis Plains, *Halse 31 Mar 1973* (probably slightly north of the flora area). Along the "old" Tinajas Altas Pass road (a bit north of the present Tinajas Altas Pass road), UTM 11 7 72 843 E, 35 81 704 N (WGS 84), 1050 feet, common, 18 Apr 2011, *Malusa,* photo.

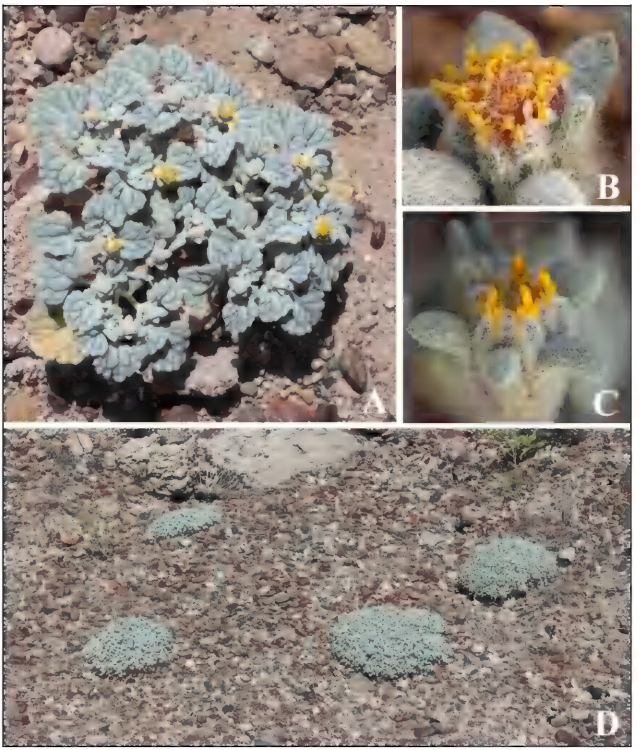

Figure 91. *Psathyrotes ramosissima*. (A & D) Ancient pebbly sediment deposit of Gila River near Sears Point, Maricopa Co., 5 Apr 2014. (B & C) Owens Valley, Chalk Bluff Road, Inyo Co., CA, 24 Apr 2008, photo by Steve Matson (CalPhotos).

Pseudognaphalium

Worldwide; 100 species. Gnaphalieae.

Pseudognaphalium canescens (de Candolle) Anderberg
[*Gnaphalium canescens* de Candolle. *G. texanum* I.M. Johnston. *G. wrightii* A. Gray]
Wright's cudweed. Figure 92.

Herbaceous, short-lived perennials, often 20–40 (70+) cm tall, relatively robust and with white-woolly (tomentose) herbage. Leaves alternate, sessile, 2–6.5 cm long, oblanceolate, and entire, the leaf bases scarcely or not decurrent. Flower heads 4–5 mm wide, with shiny, papery phyllaries (bracts). Florets many; outer florets pistillate, the inner florets fewer and bisexual; achenes 0.8–0.9 mm long, the pappus with about a dozen bristles falling in clusters or easily fragmented rings (Figure 64).

Rocky slopes especially at higher elevations and canyons in the Ajo Mountains. It does not extend farther into the desert. Many plants established in the scour zone of Alamo Canyon after the epic flood of September 2012.

Figure 92. *Pseudognaphalium canescens*. Alamo Canyon: (A) 21 Sep 2008; (B) 9 Sep 2013; (C) 7 Sep 2013.

Southwestern United States to central Mexico.

OP: Alamo Canyon, *Nichol 4 May 1939* (ORPI). Bull Pasture Trail, 3000 ft, 4 Nov 1979, *Bowers 1927*. Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-273*. Trail from Estes Canyon to Bull Pasture, 2908 ft, 18 Mar 2005, *Rutman 20050318-1*. Wash bed of S fork of Alamo Canyon, 2400 ft, 7 Sep 2013, *Rutman 20130907-6*.

Psilostrophe

Western United States and Mexico; 7 species. Heliantheae, Gaillardinea.

Psilostrophe cooperi (A. Gray) Greene

Paper daisy, paper flower. Figure 93.

Much-branched mound-shaped perennials 30–75 cm tall, probably not long-lived and sometimes flowering in first season. Stems, leaves, and phyllaries densely white woolly, the stems and leaves less woolly to glabrate with age. Stems leafy; leaves alternate, often 2.5–5+ cm long, linear, gray-green, quickly drought deciduous. Heads on peduncles mostly 2–8 cm long; phyllaries mostly 6–7 mm long, green beneath the woolly hair, lanceolate, thickened and callus-like basally and

along the midrib. Flowers bright yellow; rays 1–1.7 cm long and about as wide, 3-lobed at tip, turning downward at maturity. Achenes 3 mm long, glabrous, light colored, truncate at apex; pappus of 4–6 scales. Flowering at various seasons including spring and fall, dormant during the cooler months.

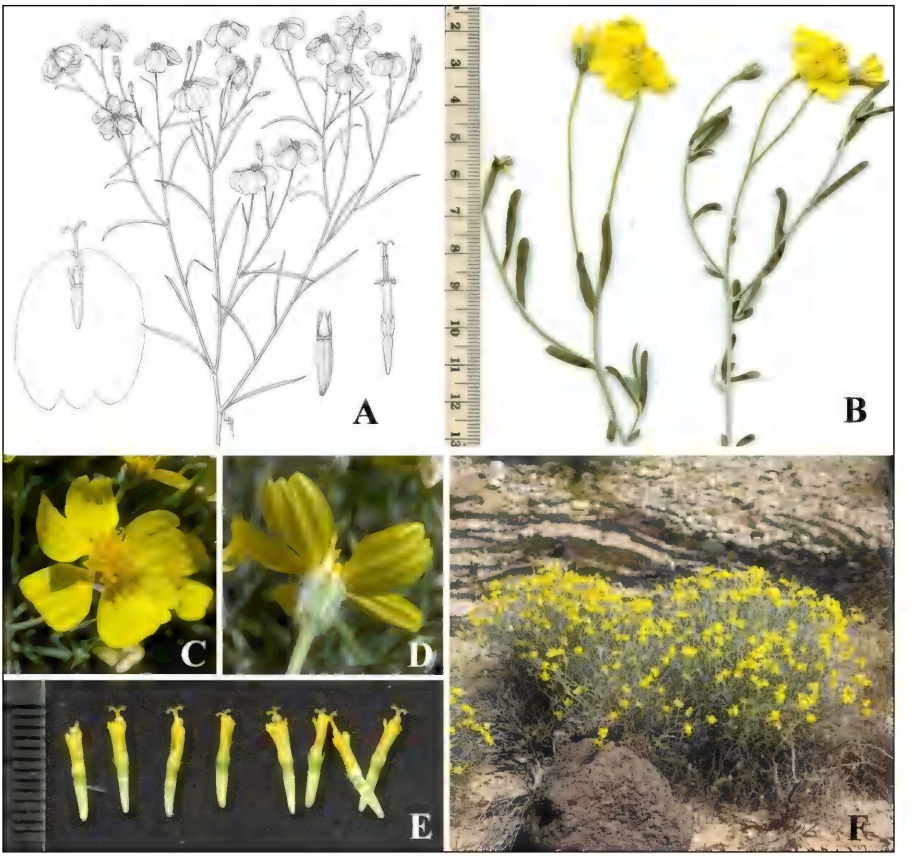

Figure 93. *Psilostrophe cooperi*. (A) By Lucretia Breazeale Hamilton. (B) Road shoulder, Hwy 86, mile 62, E of Why, 1 Aug 2014. (C & D) Red Rock Loop Road, Sedona, Yavapai Co., 8 Jun 2005, photos by Max Licher (SEINet). (E) Wash crossing N end of Ajo Mountain Drive, 30 Sep 2014. (F) Base of latite hill, Gunsight Hills, 23 Apr 2010.

Rocky slopes and washes on the east side of Cabeza Prieta and widespread in Organ Pipe on sandy-loamy soils of lower bajadas, small washes, hills, mountains, and roadsides.

Arizona to northern Sonora, southeastern California, Baja California, Nevada, and Utah.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939* (ORPI). Walls Well, *Nichol 28 Apr 1939*. 10 mi N of Sonoyta, *McDougall 22 Mar 1941*. Dripping Springs, *Hesselberg 10 April 1970*. Valley of the Ajo, 31 Mar 1980, *Stimson 224*.

CP: Charlie Bell Road east of Growler Mts (Simmons 1966). Daniels Arroyo, 26 Sep 1992, *Harlan 322*. Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-302*. Growler Mts, 1.1 mi S and 0.7 mi E. Growler Peak, 830 m, 24 Mar 2009, *Holm 20090324-2*.

Rafinesquia

Tap-rooted winter-spring ephemerals with milky sap. First leaves in a basal rosette, petioled and pinnatifid, the stem leaves alternate, reduced upwards, sessile, pinnately lobed, the leaf bases usually clasping the stem. Heads showy with ligulate (ray-like) florets only, the florets progressively smaller inward. Flowers mostly white. Achenes narrow and tapering to a beak (neck) below the pappus; pappus bristles slender and plumose. Two species. Cichorieae.

1. Larger (outer) rays often 10 mm long; achenes 9–12 mm long; pappus bristles plumose to tip, plumose hairs of pappus (the tiny branchlets) straight…… **Rafinesquia californica**
1. Larger (outer) rays (15) 20–30 mm long; achenes 12–14 mm long; uppermost one-fifth to one-fourth of pappus bristles not plumose (lacking branchlets), the lower part of pappus bristles with plumose and often cobwebby hairs. ……... **Rafinesquia neomexicana**

Rafinesquia californica Nuttall
California chicory. Figure 94.

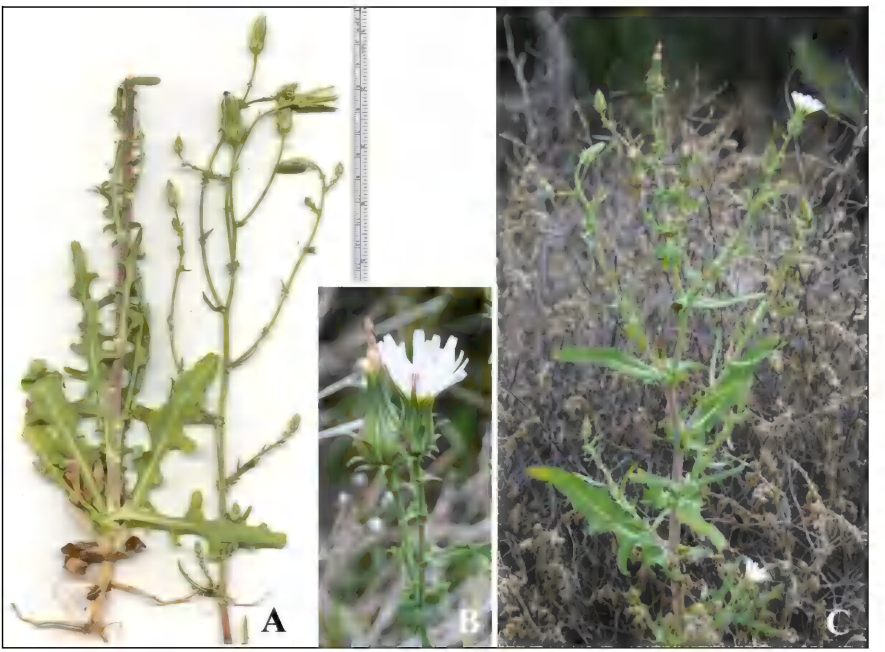

Figure 94. *Rafinesquia californica*. Estes Canyon: (A) 23 Mar 2008; (B & C) 18 Mar 2005.

Often 15–30+ cm tall with a single or few-branched, self-supporting main stem. Leaves variously pinnately cleft or dissected; lower leaves 5–8 (15+) cm long, withering as the stem develops. Flower heads highly variable in size depending on plant size and soil moisture; larger (outer) rays often 10 mm long, white except for a broad rose-purple mid-stripe on the lower (outer) surface, the rays of the inner florets white with yellow at the summit of the throat forming a yellow center or eye on the flower head. Achenes 9–12 mm long; pappus bristles 6–10+ mm long.

Common in Ajo Mountains at higher elevations and in large canyons, and also recorded from Childs Mountain.

Entering the upper elevations and margins of the Sonoran Desert in central and southern Arizona, northern Sonora, and Baja California, and also in California, Nevada, and Utah.

Differing from *R. neomexicana* by the often more robust habit, single- to few-branched and generally self-supporting and stouter main stems, broader leaf segments, generally smaller flower heads that do not open widely, achenes thicker, more sculptured, glabrous, and shorter, with more slender achene beaks, and a different pappus structure. The two sometimes grow intermixed.

OP: Alamo Canyon, 24 Mar 1941, *McDougall 29*. Estes Canyon, 2500 ft, 5 Apr 1978, *Bowers 1203* (ORPI). Bull Pasture trail, 2785 ft, 9 Apr 2005, *Felger 05-169*.
CP: Childs Mt, summit, 2845 ft, 9 Apr 1993, *Felger 93-299*.

Rafinesquia neomexicana A. Gray
Desert chicory. Figure 95.

Plants mostly 15–60 cm tall. Stems usually zigzag, often stout although weak and herbaceous. Basal rosette leaves 4–10 cm long, quickly withering as the stem develops, the blades thin, the segments broad when the plants are well watered, and thread-like when developing under drier conditions. Flower heads relatively large, the size highly variable depending on plant size and soil moisture. Larger (outer) rays (15) 20–30 mm long, pure white except for a pale rose-purple mid-stripe on the lower (outer) surface, the innermost florets white with yellow at the summit of the throat. Inner phyllaries (13) 17–22 mm long. Achenes 12–14 mm long; pappus bristles mostly 10–15 mm long, plumose except at tips, dull white, often cobwebby below.

The plants often grow in the protection of small shrubs, the flowering stems overtopping the "nurse" shrub, which is often *Ambrosia deltoidea* or spiny shrubs especially in drier years and places. The tops of the plants are often eaten by animals. Widespread across the region; sandy to rocky soils, dunes, washes, plains, and slopes, lowlands and mountains to higher elevations. It has been in the region for more than 10,000 years.

Baja California, Baja California Sur, Chihuahua, northern Sonora, and southeastern California to western Texas, Nevada, and Utah.

OP: Growler Valley, 20 Mar 1933, *Shreve 6206*. Alamo Canyon, 2500 ft, *Nichol 14 Mar* 1939. Aguajita, wash, 13 Mar 1992, *Felger 92-244*. Santa Rosa Mts, 12 Mar 2003, *Felger 03-346*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger*, observation.
CP: Tule Well, 11 Mar 1937, *Harbison 26156*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3948*. Papago Well, 26 Feb 1993, *Felger 93-139*. Pinta Sands, 11 Apr 1993, *Felger 93-404*.
TA: Tinajas Altas Pass, along wash, 20 Feb 1979, *McLaughlin 1974*. Coyote Water, 21 Feb 2005, *Felger 05-151*. †Tinajas Altas, achenes, 10,070 ybp.

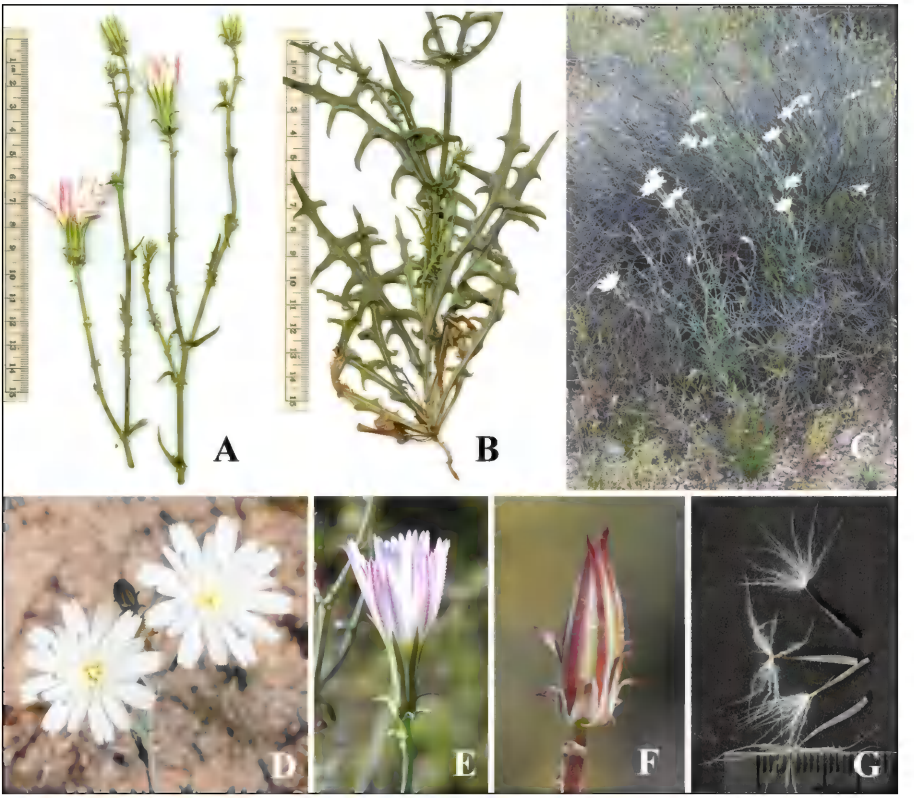

Figure 95. *Rafinesquia neomexicana*. Hwy 85, 0.5 mile S of N boundary of Organ Pipe: (A) 14 Feb 2015; (E) 13 Feb 2005. (B) Kuakatch Wash at Hwy 85, 9 Mar 2015. (C) North Puerto Blanco Drive at Red Tanks Trail, 12 Mar 2015. (D) North Puerto Blanco Drive, 29 Feb 2008. (F) Chico Sunie Wash near Chico Suni Village, 25 Feb 2005. (G) Hwy 86 near mile marker 62, 5 Apr 2015.

Senecio

Ephemerals or perennial herbs or subshrubs. Leaves alternate or basal, often with stipule-like leaf bases. Heads with ray and disk florets, or rays sometimes absent; rays in a single row, their number related to the number of phyllaries. Involucres usually cylindrical-campanulate, the phyllaries equal or nearly so, and often also with an outer series of smaller accessory (calyculate) bracts. Flowers yellow. Achenes columnar; pappus of numerous fine, white, soft capillary hairs. The generic name derives from the Latin *senex* ("old man"), referring to the many white pappus hairs, said to resemble the beard of an old man.

Worldwide; 1000 species. Heliantheae, Senecioneae.

1. Leaves often semi-succulent, pinnatisect with pectinate segments (narrowly linear segments spreading at right angles)..... **Senecio flaccidus**
1. Leaves various but not semi-succulent and not pectinately pinnatisect.

2. Leaves not noticeably thin; pinnately lobed, the terminal lobe largest and with toothed margins; phyllaries in a single series, or with an inconspicuous lower series (the calyculus). ..... **Packera quercetorum**

2. Leaves noticeably thin; variously toothed to irregularly lobed but not pinnately lobed; phyllaries in 2 series, the lower series (the calyculus) reduced but readily visible.

3. Stems and leaves green, with woolly tufts at leaf bases and axils; rays conspicuous, 10 mm long..... **Senecio lemmonii**

3. Stems and lower leaves glabrous and often purple-green; rays none or sometimes inconspicuous and several mm long..... **Senecio mohavensis**

Senecio flaccidus Lessing var. **monoensis** (Greene) B.L. Turner & T.M. Barkley
[*S. monoensis* Greene]
Sandwash groundsel. Figure 96.

Figure 96. *Senecio flaccidus* var. *monoensis.* (A) San Pedro Riparian National Conservation Area, Cochise Co., 12 Apr 2003, photo by Liz Makings (SEINet). (B–D) Sedona, Yavapai Co., 3 May 2001, photos by Max Licher.

Winter-spring ephemerals, glabrous or glabrate. Leaves sessile or short-petioled, mostly 3–10 cm long, the blades divided into narrow spreading lobes (pectinate). Flowers heads usually in compound clusters, with bright yellow ray and disk florets, rays 10–20 mm long. Phyllaries 7–10 mm long. Achenes hairy.

Organ Pipe in sandy gravelly soils in washes in the Bates and Growler mountains. Apparently rather scarce in the flora area.

This species ranges from southwestern United States to Puebla and Veracruz, Mexico. Variety *monoensis* is largely a plant of the Mojave and Great Basin regions, where it is perennial. The Sonoran Desert plants are annuals but resemble the Mohave Desert plants in having highly dissected leaves and green foliage (comparatively glabrate) and a herbaceous habit, whereas vars. *flaccidus* and *douglasii* are conspicuously white-hairy as well as being shrubs.

OP: Growler Canyon, wash with *Ambrosia ambrosioides* and *Baccharis glutinosa*, 30 Mar 1979, *Bowers 1600*.

Senecio lemmonii A. Gray
Lemmon groundsel. Figure 97.

Figure 97. *Senecio lemmonii*. Bull Pasture Trail: (A) 7 Mar 2014; (C) 30 Mar 2008. (B) S fork of Alamo Canyon, 12 Mar 2005. (D) Poland Creek, Bradshaw Mts, Yavapai Co., 3 Apr 2001, photo by Max Licher (SEINet).

Ephemerals, mostly in spring or sometimes short-lived perennials, highly variable in size, often 25–65+ cm tall, glabrate except woolly tufts in leaf axils and moderately woolly leaf bases. Stems leafy, the leaves 4–14 cm long, green, petioled below, sessile above and clasping the stem, the blades thin, mostly lanceolate to elliptic, toothed to sometimes entire. Heads 10–13 mm long, the

phyllaries 6–7.5 mm long with dark tips. Flowers bright yellow; rays well developed, 8–13 in number, 10 mm long. Achenes 3.5–3.7 mm long with short white hairs.

Often in shaded or north-facing niches, widely scattered and not common, usually among rocks; mountains, especially at higher elevations in the eastern part of Cabeza Prieta and widespread in Organ Pipe to the top of the Ajo Mountains.

Western and southern Arizona, Sonora, Baja California, and Baja California Sur.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10849*. Alamo Canyon, *Nichol 4 May 1939*. S side of Arch Canyon, 28 Mar 1965, *Lockwood 192*. Twin Peaks, 1900 ft, shady places on north slope, 4 Mar 1984, *R.K. Van Devender 84-47*. Growler Mts, 7 Mar 2003, *Rutman 2003-243* (ORPI). Canyon upstream from Bates Well, 11 Mar 2003, *Felger 03-294*. Sierra Santa Rosa, 12 Mar 2003, *Felger 03-314*.

CP: Agua Dulce Mts, near main ridge, 2000 ft, N exposure, *Simmons 24 Jan 1965*. Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-292*. Growler Mts, 1.1 mi S and 0.7 mi E Growler Peak, N-facing slope, 24 Mar 2009, *Holm 20090324-1*.

Senecio mohavensis A. Gray
Mojave groundsel. Figure 98.

Delicate, glabrous winter-spring ephemerals 12–30 (40) cm tall. Stems leafy, solitary to well branched above. Stems and lower leaves usually purple-green. Leaves mostly 2–9 cm long, ovate to obovate, irregularly toothed to coarsely lobed, thin and almost membranous; lower leaf surfaces often purplish, the upper leaves sessile and broadly clasping the stem. Flower heads 8–13.5 mm long; corollas yellow, with disk florets only or rays occasionally present but inconspicuous. Phyllaries (6) 7–8.5 mm long. Achenes 2.8–3.2 mm long, cylindrical, with short white hairs.

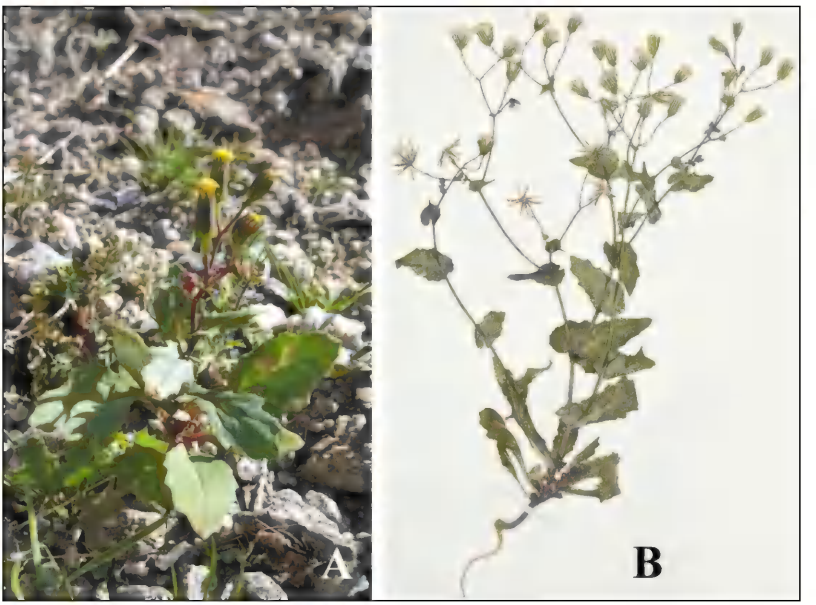

Figure 98. *Senecio mohavensis*. (A) Sierra Estrella Wilderness, 13 Feb 2009, photo by Les Landrum (SEINet). (B) W flanks of Sierra Estrella Mountains and Wilderness Area, 20 Mar 1994, *Hodgson 8090* (DES).

Often in protected, shaded places among rocks in canyons and on north-facing mountain slopes. Widely scattered across the flora area but seldom common.

Mojave and Sonoran deserts in Arizona, Baja California, Baja California Sur, California, Nevada, and Sonora.

The seeds retain viability for at least 15 years and the achenes become mucilaginous when wet. *Senecio mohavensis* resembles the Mediterranean *S. flavus* but is less closely related to it than to a previously recognized variety of *S. flavus* that is now known as *S. mohavensis* subsp. *breviflorus* (Kadereit) M. Coleman. *Senecio mohavensis* probably reached the New World through relatively recent long-distance bird dispersal (Coleman et al. 2001; Liston et al. 1989).

OP: Headquarters Area, 10 Apr 1941, *McDougall 76*. Quitobaquito, N-facing rocky slope, localized beneath shrubs, 29 Mar 1988, *Felger 88-114*.

CP: Cabeza Prieta Tank, 6 Apr 1979, *Lehto L23513* (ASU). Agua Dulce Spring, 26 Feb 1993, *Felger 93-91*. Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-293*.

TA: Tinajas Altas, on granite, *Van Devender 26 Mar 1983*.

***Sonchus** – Sow-thistle

Winter-spring ephemerals with milky sap. Leaves alternate. Heads ligulate with pale yellow ray-like florets. With age the phyllaries often become swollen and callus-like at the base. Achenes compressed, with three prominent ridges (ribs) on each side, beakless and truncate at apex; pappus of numerous fine, soft hairs plus a few deciduous scales.

Native to the Old World; 50 species; some are worldwide weeds. Cichorieae.

1. Stems sometimes more than 1 m tall; plants usually conspicuously spinescent; achenes smooth between ribs, the ribs not knobby, the margins thin and wing-like..... **Sonchus asper**
1. Stems seldom reaching 1 m tall; plants not conspicuously spinescent; mature achenes wrinkled and roughened between the ribs (caution: achenes may need to be mature), the ribs transversely knobby, the margins not thin and wing-like..... **Sonchus oleraceus**

***Sonchus asper** (Linnaeus) Hill subsp. **asper**

Spiny sow thistle; *chinita*; ho'idkam, 'i:vakĭ. Figure 99.

Larger plants spiny-prickly, often robust, sometimes reaching 1.8 m in height but usually much smaller. Mostly glabrous except stalked glands reaching 1–1.3 mm in upper part of the plant. Leaves pinnatifid with an enlarged terminal segment, and often with spinescent-tipped teeth; early leaves in a rosette, 6–30+ cm long, the rosette and lower stem leaves with winged petioles, the upper leaves sessile and clasping the stem; lowermost leaf segments (basal auricles) of stem leaves rounded (on giant, robust plants the basal auricle can be deeply cut with many spinescent teeth). Achenes 2.8–3 mm long, flat, oval to oval-obovate; pappus more or less deciduous.

Localized and seldom numerous, mostly at waterholes, especially artificial ones and other disturbed habitats, and along washes and canyons.

Native of Europe, naturalized and weedy worldwide.

OP: Quitobaquito, *Nichol 4 May 1939*. Visitor Center, *Beal 19 Mar 1989* (ORPI).

CP: Jose Juan Tank, 26 Feb 1993, *Felger 93-98*. Charlie Bell Road at W branch of Daniels Arroyo, 10 Apr 1993, *Felger 93-359*.

TA: Coyote Wash at Camino del Diablo, 10 Jan 2002, *Felger 02-10*. Frontera Canyon, 18 Mar 1998, *Felger*, observation.

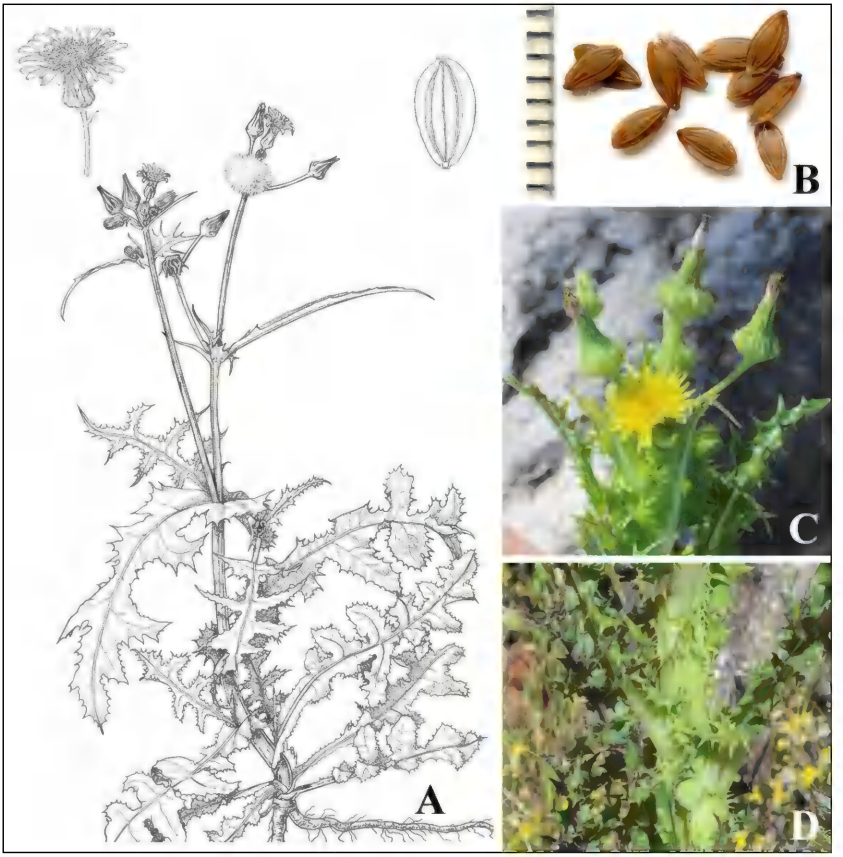

Figure 99. *Sonchus asper* subsp. *asper*. (A) By Lucretia Breazeale Hamilton. (B–D) Alamo Canyon, 4 Apr 2015.

***Sonchus oleraceus** Linnaeus
Sow thistle; *chinita*; hauvĭ, hehewo. Figure 100.

Similar to *S. asper* but usually not nearly as large and robust, the lowermost leaf segments (basal auricles) of stem leaves narrow-angled (acute), the achenes generally narrower, roughened between the ribs, the margins not thin and winged, and the pappus tending to be persistent. Achenes 2.5–3.4 mm long, narrowly elliptic to oblanceolate.

Widely scattered in canyons, washes, waterholes; disturbed habitats and also well established and widespread in natural areas but seldom common, and in the Ajo Mountains to more than 4000 feet.

Native of Europe, naturalized and weedy worldwide.

Figure 100. *Sonchus oleraceus*. Alamo Canyon: (A) 2 Mar 2008; (B) 12 Jan 2014; (D) 11 Jan 2014. (C) Estes Canyon, 2 Mar 2008. (E) Ajo, 5 Mar 2015.

OP: Wash near Sonoyta road, 10 Apr 1941, *McDougall 71*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1594*. Quitobaquito, 10 Nov 1987, *Felger 87-301*. Bull Pasture, 9 Apr 2005, *Felger 05-188*.

CP: Childs Mt, 9 April 1993, *Felger 93-284*. Charlie Bell Road at W branch of Daniels Arroyo, 9 April 1993, *Felger 93-359*.

TA: Frontera Canyon, 18 Mar 1998, *Felger*, observation.

Stephanomeria – Wire-lettuce

Ephemerals or perennial herbs or small shrubs with milky sap. Leaves alternate, often scale-like and reduced upwards. Involucres cylindrical, often narrow, the phyllaries about 5, in a single series and nearly equal, plus smaller, accessory bracts. Heads ligulate, few flowered, the florets ray-like and equal in size; corollas white to pink or rose. Achenes columnar, beakless, 5-angled or 5-ribbed; pappus bristles plumose.

Western North America and northern Mexico; 16 species. Cichorieae.

1. Bushy perennials (sometimes flowering in the first season), the stems much branched throughout; rays (ligules) 10–12 mm long; pappus bristles 6–8 mm long..... **Stephanomeria pauciflora**
1. Spring ephemerals with one to several erect main stems, branched above; rays 5–7 mm long; pappus bristles 2–5 mm long.

2. Pappus bristles 10 (or more?), slender and rounded in cross-section (capillary), 5 mm long; Organ Pipe, not on dunes or sand flats..... **Stephanomeria exigua**
2. Pappus bristles 5, conspicuously flattened, 2–3 mm long; dunes and sand flats in Cabeza Prieta. ..... **Stephanomeria schottii**

Stephanomeria exigua Nuttall subsp. **exigua**
Wire-lettuce. Figure 101.

Spring ephemerals less than 30 cm tall, with a stout taproot and a soon-withering basal rosette of leaves. Flowers pink, becoming dull with age.

Known in the flora area from near the north end of the Pozo Nuevo Hills where it grows on heavy floodplain soils and also locally in the Crater Range north of Ajo.

This highly variable species occurs in western North America and this subspecies ranges from Baja California and Sonora to Colorado, Texas, and Washington.

OP: 8 mi S of Growler Well, Bates Mts, 1300 ft, *Nichol 17 Apr 1939* (ORPI). Floodplain near N end of Pozo Nuevo Hills, 11 Apr 2003, *Rutman 2003-457*.

Stephanomeria pauciflora (Torrey) A. Nelson
Desert straw. Figure 102.

Globose or mound-shaped herbaceous perennials or shrubs with sparse foliage. Glabrous except a single collection (*Bowers 910*) that has densely pubescent herbage with short, white (pilose) hairs but in every other respect compares with *S. pauciflora*. Leaves variable, quickly drought deciduous, pinnatifid with few, spreading narrow segments, the early leaves of well-watered plants sometimes 10–15 cm long but usually much shorter, the segments usually less than 5–8 mm long; first leaves (of first-season plants) in a basal rosette. Flowers pale pink, closing by mid-day or earlier in warmer weather; flowering non-seasonally.

Common and widespread, especially along larger washes, also canyons and rocky slopes, sometimes to mountain peaks, and less common on creosotebush flats.

California and Arizona to Colorado and Kansas, and southward to Baja California Sur, Sonora, Chihuahua, and Coahuila.

OP: Pitahaya Canyon, 3400 ft, *Nichol 23 Feb 1939*. 6.7 mi NE of Visitor Center along Ajo Mountain Drive, 1900 ft, 5 Nov 1977, *Bowers 910*. Aguajita Spring, arroyo, 13 Sep 1986, *Felger 86-293*.

CP: Tule Well, 28 Oct 1937, *Gentry 3520* (DES). Pinta Sands: *Simmons 16 Apr 1963* (CAB); 8 May 1978, *Lehto L22764* (ASU). Sierra Pinta, summit, *Cain 15 Nov 2003*. *Felger*, observations: N side of Tule Mt, 2 Feb 1992; Heart Tank, 14 Jun 1992; Childs Mt, 2845 ft, 18 Aug 1992.

TA: 1 mi E of Tinajas Altas, 26 Apr 1986, *Van Devender 86-144*.

Figure 101. *Stephanomeria exigua*. Hwy 85, W of Three Points near mile marker 125, 16 Apr 2015.

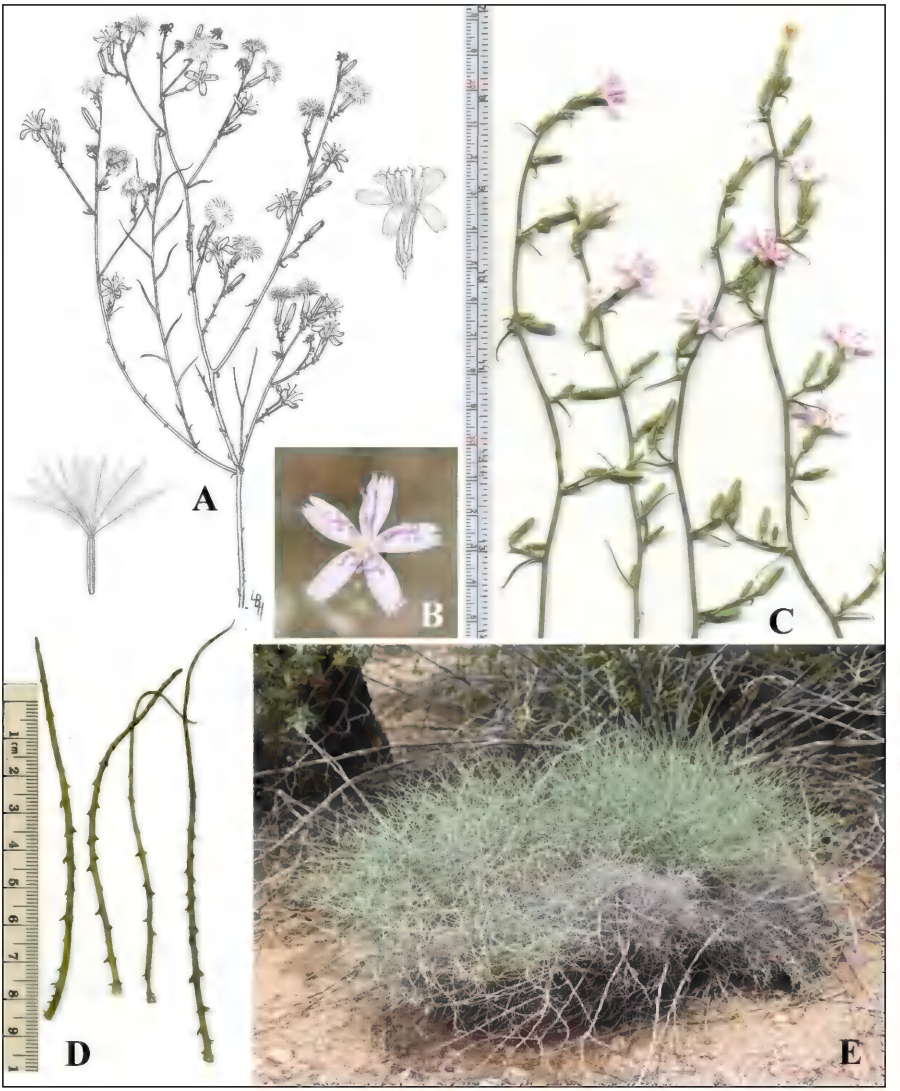

Figure 102. *Stephanomeria pauciflora*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon, 6 May 2006. (C) Ajo, 1 Apr 2013. (D) Aguajita Wash near US/Mexico boundary, 8 Feb 2015. (E) Senita Basin, 10 May 2010.

Stephanomeria schottii (A. Gray) A. Gray
[*Hemiptilium schottii* A. Gray]
Schott's wire-lettuce. Figure 103.

Spring ephemerals often 30–60 cm tall, with a stout taproot, and shiny, silvery-white stems. Early leaves thin, in a quickly withering basal rosette, 2.8–12 cm long, linear with a few teeth or pinnate segments 1–3 cm long; the plants nearly leafless at flowering time. Flowers white tinged with violet. Pappus bristles uniquely broad and flattened, with a coppery mid-stripe and broad, nearly transparent margins, the bristles with feathery tips. Flowering March to May.

Figure 103. *Stephanomeria schottii*. (A) By Amy Eisenberg. (B–D) Dunes 20 mi S of Sonoyta, Sonora, on Mex Hwy 8, 17 Mar 2014.

Generally on sand flats and dunes. Seasonally common on the Pinta Sands and a small sand area at the west margin of the San Cristobal Wash.

Also common on the Mohawk Dunes to the north of Cabeza Prieta, and similar habitats farther west in the Goldwater Range. It is especially common on the Gran Desierto dunes and sand flats in adjacent northwestern Sonora.

Southwestern Arizona and northwestern Sonora.

After its initial discovery there was no report of this plant for more than 100 years (Lehto 1979), which is surprising since it is fairly common. Mature plants tend to be foul-smelling. The flowers are open at dawn (nocturnal?), at which time they can produce an almost sickeningly sweet fragrance, and remain open through mid-morning on warm days and longer on cooler days.

CP: 2 mi beyond [presumably westward from] San Cristobal Wash on Bates Well–Papago Well Road, *Larrea-Ambrosia* plain, ephemerals to 0.8 m tall, erect, branching laterally from main axis, common along gully and in the open and among shrubs, 1000 ft, 16 Apr 1976, *Engard 876* (DES). Pinta Sands: 8 May 1978, *Lehto L22764*; 10 Apr 1978, *Reeves 6780*; 11 Apr 1993, *Felger 93-438*. W margin of San Cristobal Wash, 10 Apr 1993, *Felger 93-379*.

Stylocline – Nest straw

Diminutive white-woolly spring ephemerals. Leaves alternate or appearing whorled beneath flower heads; leaves entire, sessile or petioles obscure, the lower leaves soon withering. Flower heads small, distinctly rounded, single or usually in clusters (glomerate) of 2–10, subtended by several leaves longer than the cluster of flower heads and seemingly functioning like phyllaries. Actual phyllaries absent (the species in the flora area). Receptacles longer than wide, cylindrical to club-shaped or linear. (The elongate receptacle is a conspicuous characteristic and often one easy to see except in immature plants, but it is not necessarily diagnostic.)

Pistillate florets in 2 to several outer series or rows, spirally arranged, lacking a pappus and without stamens; pistillate florets all subtended by phyllary-like chaffy bracts, at least the inner of these pouch-like, very woolly outside, and with an expanded membranous tip or margin; the bract and achene falling as a unit (chaffy bracts of innermost pistillate florets may be reduced) (Figure 64). Pistillate achenes smooth and shiny, tiny, without a pappus. Inner florets staminate, 2–6, in 1 series (spiral), the corolla lobes usually 5, the chaffy bracts absent or small, achenes vestigial or aborting, the pappus of 0–12 barbed bristles.

Southwestern United States and northwestern Mexico; 7 species. Some birds incorporate these small woolly plants into their nests, hence the common name. Gnaphalieae.

1. Membranous (hyaline) wing of achene-bearing chaffy bracts broadest near or below middle of whole bract, cordate or rounded..... **Stylocline gnaphaloides**
1. Wing of achene-bearing chaffy bracts broadest well above middle of whole bract. ..... **Stylocline micropoides**

Stylocline gnaphaloides Nuttall
[*S. arizonica* Coville]
Everlasting nest-straw. Figure 104.

Resembling *S. micropoides* but generally smaller in stature. Larger leaves to 2 cm long, broadly linear to oblong, generally obtuse. Membranous (hyaline) wing of fruiting chaffy bracts ovate (broadest near base), or often heart-shaped (ovate-cordate) at base, extending over full length of

bract (chaff body). Pistillate achenes 0.8–1 mm long. Achenes of inner, staminate florets vestigial, generally with 1–4 pappus bristles.

Known from the flora area by a single record near the Mexican border but perhaps more widespread. Also recorded in a similar habitat about 20 km southward in Sonora.

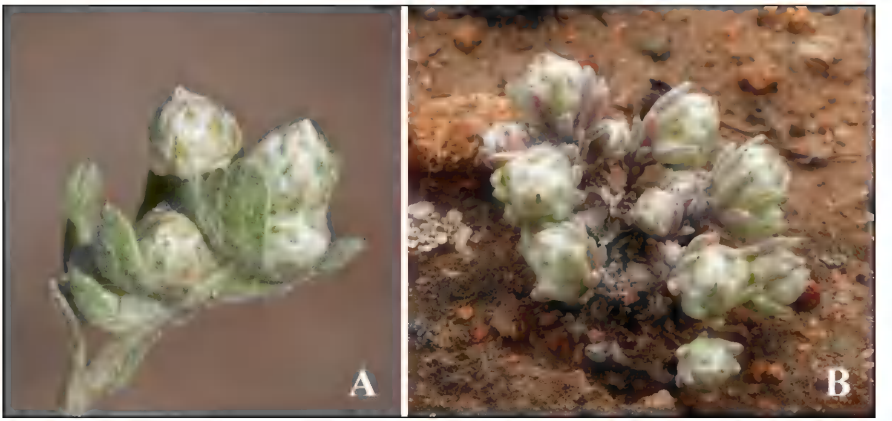

Figure 104. *Stylocline gnaphaloides*. (A) S of Ben Lommond on Quail Hollow Road, Santa Cruz Co., 14 May 2014, photo © by Richard Spellenberg (CalPhotos). (B) Santa Rosa Island, Santa Barbara Co., CA, 7 May 2006, photo by Steve Matson (CalPhotos).

This is primarily a cismontane Californian species, extending into similar habitats in the Baja California Peninsula (Rebman et al. 2016) and barely reaching the western edge of the California desert. Another center of distribution is in Arizona from Organ Pipe to the southeastern part of Arizona and adjacent northern Sonora. There is apparently a distributional gap in the intervening, extremely arid desert (Morefield & Felger 2000).

Distinguished from *S. micropoides* by the often smaller, relatively broader and blunter leaves, smaller flower heads, usually fewer pappus bristles, and most readily by the broad, ovate or heart-shaped wing of the chaffy bracts. The two species often grow intermixed and *S. gnaphaloides* sometimes also grows with *Logfia depressa*.

OP: Senita Basin Road, 4.5 mi S of Senita Basin, along wash, 23 Mar 1969, *Lehto L15440* (ASU 18822, mixed sheet with *Logfia depressa*, det. James D. Morefield, 1992).

Stylocline micropoides A. Gray
Desert nest-straw. Figure 105.

Plants mostly much less than 15 cm tall, erect to low and spreading. Larger leaves often to 2 cm long, oblanceolate to lanceolate or awl-like, acute to acuminate. Clusters of flower heads (glomerules) subtended by leaves longer than the flower heads. Individual heads globose. Receptacles cylindrical, 2.5–3.5 × 0.5–0.6 mm, persistent long after the florets fall, each floret leaving a minute pit at its point of attachment. Largest chaffy bracts 3.4–4.5 mm long, enclosing achenes, each falling with an achene as a unit, the bract wing broadly lanceolate or oblanceolate to ovate or obovate. Pistillate achenes 1–1.3 mm long, smooth and shiny. Achenes of inner, staminate florets vestigial, generally with 3–8 pappus bristles.

Common across the desert floor including washes, creosotebush flats, and dunes, as well as soil pockets and small flats on hills and mountains, and extending to the crestline in the Ajo Mountains.

Western and southern Arizona to western Texas, California, Utah, Baja California, Chihuahua, and Sonora. Distinguished by distinctive globose heads and long bracts.

OP: Cement Tank, 14 Apr 1941, *McDougall 96*. Arch Canyon, 28 Mar 1965, *Niles 553*. Wash 2.5 mi W of Hwy 85 on Puerto Blanco Drive, 11 Apr 1978, *Bowers 1218*. Bull Pasture, *Beale 26 Mar 1988* (ORPI). Quitobaquito, 29 Mar 1988, *Felger 88-115*. Base of Santa Rosa Mts, *Rutman 3 Feb 2003* (ORPI). Trail to Mt Ajo, crestline above The Cones, 4090 ft, 10 Apr 2005, *Felger*, observation.

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3926*. Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-294*. Pinta Sands encroaching E side of Pinacate Lava, growing with *Logfia depressa* (*93-400*), 11 Apr 1993, *Felger 93-399*.

TA: Tinajas Altas: *Van Devender 5 Mar 1983*; 19 Mar 1998, *Felger 98-143*. Coyote Water, 18 Mar 1998, *Felger*, observation.

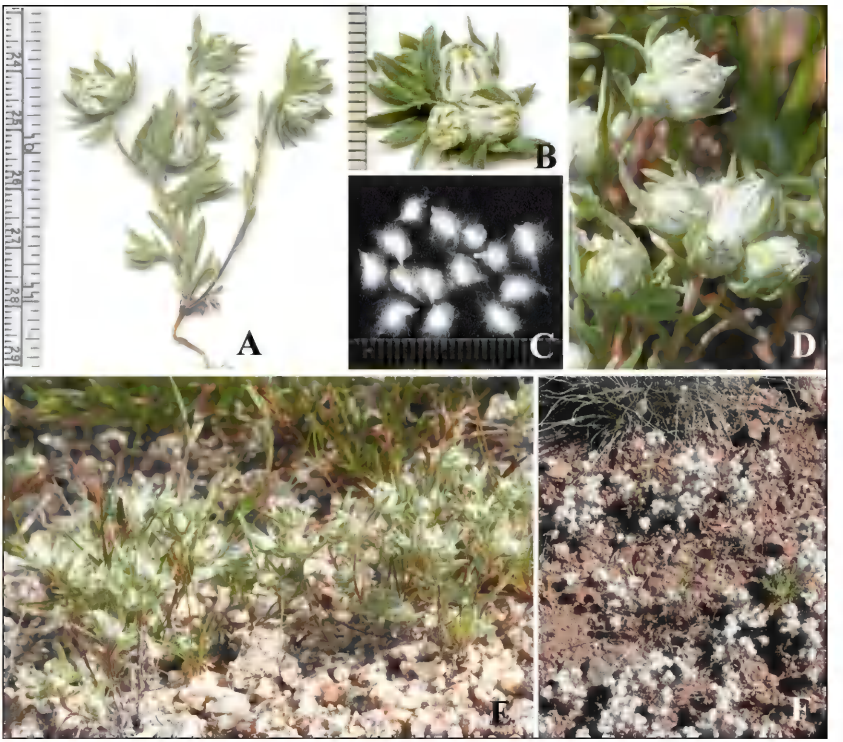

Figure 105. *Stylocline micropoides*. (A) Alamo Canyon, 11 Mar 2014. (B) Kuakatch Wash at Hwy 85, 9 Mar 2014. (C) Hwy 86, near mile marker 62, 5 Apr 2015. (D & E) Near Victoria Mine, 5 Mar 2005. (F) Bull Pasture, 10 Apr 2005.

Tessaria sericea, see **Pluchea sericea**

Thymophylla

Ephemerals or perennial herbs (or subshrubs elsewhere), strongly scented with conspicuous oil glands. Leaves and branches opposite below, often alternate above. Phyllaries united at least ⅔ of their length and with mostly round glands, and also with a series of smaller, accessory bracts (calyculi). Rays few, fertile, or sometimes reduced or absent, usually yellow; disk florets usually numerous, bisexual and fertile. Achenes obconic; pappus highly variable.

Southwestern United States and Mexico, and South America, and introduced in the Old World; 13 species. A genus segregated from *Dyssodia*. Heliantheae, Pectidinae.

1. Leaves soft, the segments not bristly; rays white (sometimes pale yellow), the disk yellow. ..... **Thymophylla concinna**
1. Leaves firm, the segments with bristly tips; flower heads all yellow..... **Thymophylla pentachaeta**

Thymophylla concinna (A. Gray) Strother
[*Dyssodia concinna* (A. Gray) B.L. Robinson]
Dogweed; *manzanilla de coyote*; ban mansani:ya. Figure 106.

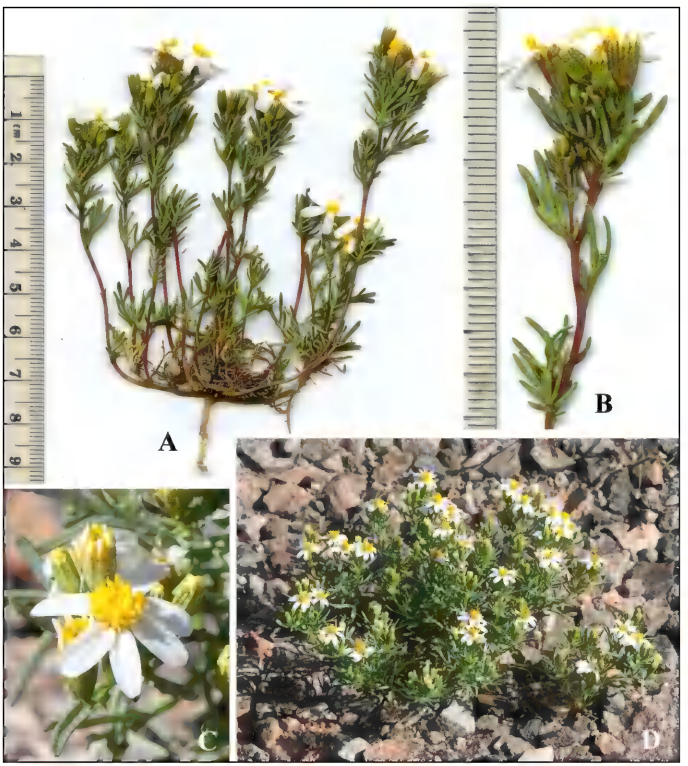

Figure 106. *Thymophylla concinna*. (A & B) North Puerto Blanco Drive near Red Tanks trailhead, 12 Mar 2015. (C & D) Near N boundary of Organ Pipe on Bates Well Road, 20 Mar 2005.

Small winter-spring ephemerals, mostly 3.5–10 cm tall, the stems becoming semi-prostrate and sometimes reaching 20 cm long. Plants glabrous or sparsely hairy, dotted with small oil glands and pungently aromatic. Leaves opposite below, alternate above, 7–16 mm long, pinnate with slender segments. Heads often clustered at ends of leafy stems, showy, the rays white, 4–5 mm long, the disk yellow. Phyllaries 4.5–6 mm long, united nearly to apex, the accessory bracts few and inconspicuous or absent. Achenes 2.8–3 mm long, slender, blackish; pappus bristles white, about as long as the achenes.

Gravelly, sandy, granitic or volcanic soils; valley plains and bajadas, and sometimes on rocky hill slopes. Near the Agua Dulce Mountains in Cabeza Prieta and widely scattered in the lowlands of Organ Pipe. Its history in the flora area extends to more than 3200 years.

Sonoran Desert in southern Arizona and central and western Sonora southward to the Guaymas Region.

The plant was boiled and the tea drunk as a medicine for colds and by women right after childbirth (Betty Melvin in Zepeda 1985: 54).

OP: Sonoyta Hills, 25 Apr 1944, *Clark 11470* (ORPI). Base of Twin Peaks, 2 Mar 1985, *Van Devender 85-4*. Quitobaquito, 29 Mar 1988, *Felger 88-119*. Gunsight Hills, 9 Mar 2003, *Rutman 2003-290* (ORPI). Santa Rosa Mts, upper bajada, 12 Mar 2003, *Felger 03-351*. †Puerto Blanco Mts, achenes, 3220 ybp.
CP: S of Agua Dulce Pass on bajada (Simmons 1966). Gravelly slopes at S edge of Agua Dulce Mts, 1400 ft, scarce, 13 Apr 1964, *Niles 341*.

Thymophylla pentachaeta (de Candolle) Small var. **belenidium** (de Candolle) Strother
[*Dyssodia pentachaeta* (de Candolle) B.L. Robinson var. *belenidium* (de Candolle) Strother]
Golden dyssodia. Figure 107.

Small, short-lived herbaceous perennials. Leaves 5–25 mm long, mostly opposite, or the upper ones alternate; simple or pinnately lobed, leaves or the lobes needle-like. Flower heads on slender peduncles 2–5 cm long, with bright yellow ray and disk florets. Achenes with pappus of awned scales. Growing and flowering in warmer months with sufficient soil moisture.

Fine-textured soils among rocks at higher elevations on Childs Mountain and widely scattered in Organ Pipe along roadsides and perhaps elsewhere; often a pioneer plant along roadsides and washes.

This variety occurs in southeastern California to southern Utah and Texas and northern Mexico, and disjunct in the Chaco of Argentina. Three other varieties range from Texas to central Mexico.

OP: 4.7 mi from entrance of N Puerto Blanco Drive, *Beale 10 Mar 1987* (ORPI).
CP: Childs Mountain, 2845 ft, 18 Aug 1992, *Felger 92-636A*.

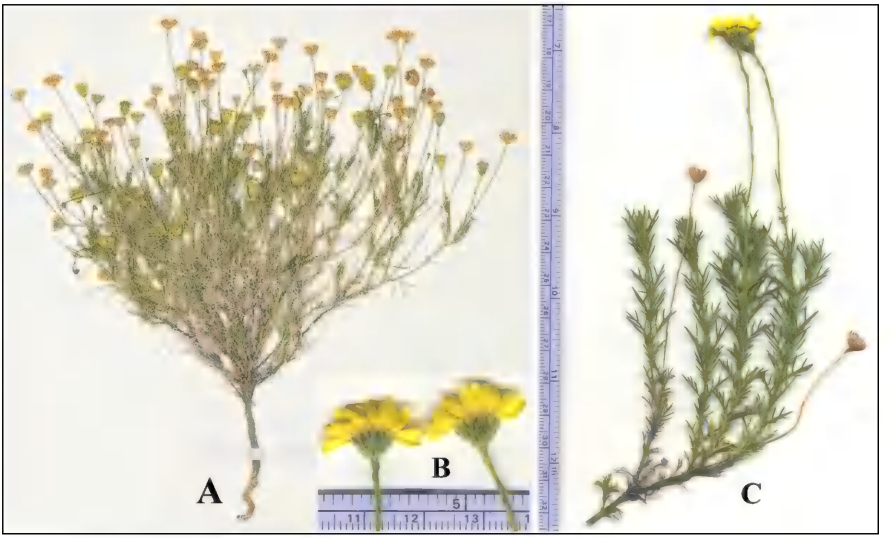

Figure 107. *Thymophylla pentachaeta* var. *belenidium*. (A) Horseshoe Mesa/Tonto Trail, Grand Canyon National Park, 4 Apr 2007, *Hodgson 21733* (DES). (B & C) Garden in Ajo, 26 Aug 2013.

Townsendia

Western North America and Mexico. *Townsendia* is a genus of 27 species centered in western United States. In Arizona it occurs mostly in the northern part of the state and primarily at higher elevations. Astereae.

Townsendia annua Beaman

Annual Townsend daisy. Figure 108.

Small, attractive cool-season ephemerals, with coarse hairs (strigose). Stems to 20 cm long but often much shorter. Leaves basal and alternate 1–2 cm long, spatulate to narrowly oblanceolate. Phyllaries numerous, lanceolate or ovate to oblanceolate with broad white-membranous (hyaline) and fringed (erose) margins. Rays 5–8 mm long, whitish, pink tinged above and purplish below (dark underside of rays is characteristic of the genus), the disk with numerous yellow florets. Achenes 2–3 mm long, with tiny knob-tipped hairs; pappus of disk achenes of pure white, flattened but slender, barbellate bristles. The attractive daisy-like flower heads are often as large as or larger than the rest of the plant.

Locally extensive population in the northwestern of part of Organ Pipe; on loamy, limestone or granitic soil in a creosotebush flat. There are no other records for any member of this genus anywhere else within the Sonoran Desert. In Arizona *T. annua* is otherwise known to range from 3000–7000 ft and the nearest "lowland" record is from near Safford in Graham County (14 Apr 1905, *Thornber 4667*). Is it really so rare in the Sonoran Desert, or has it been overlooked because of its gross similarity to *Monoptilon bellioides*?

Southeastern Utah and adjacent Colorado to Arizona, New Mexico, and western Texas, and perhaps northeastern Sonora and northern Chihuahua.

The plants resemble the common, widespread *Monoptilon bellioides*, but are readily distinguished by the softer (not bristle-like) hairs, lack of crowded, spatulate leaves beneath (subtending) the flower heads, phyllaries with wider and more prominently membranous margins (extending the length of the phyllary), flat and straight rays (not inrolling with age), distinctive pappus, and the tiny knobbed hairs on the achenes. Members of *Townsendia* generally have rays that are pink or lavender below and of a lighter shade above, but this feature can be difficult to see except on fresh specimens.

OP: Near Cherioni Well, 9 Apr 1941, *McDougall 64*. N boundary, Cuerda de Leña Wash, *Jordan 25 Mar 1975* (ORPI). Loamy flat W of Cuerda de Leña Wash near N boundary, 8 Mar 2003, *Rutman 2003-287*. W side of Cuerda de Leña, several hundred yards S of N boundary of OP, UTM: 12 320660, 3563790, 1462 ft, loamy flat dominated by *Larrea*, area that supported *Townsendia* also supported an amazing diversity of annual species, 23 Mar 2003, *Rutman 2003-389*.

Figure 108. *Townsendia annua*. Near Organ Pipe N boundary, W of Cuerda de Leña, 8 Mar 2003.

Trichoptilium

This genus has a single species. Heliantheae, Gaillardinea.

Trichoptilium incisum (A. Gray) A. Gray

Yellow head. Figure 109.

Small winter-spring ephemerals, sometimes persisting through summer and becoming short-lived perennials, with a taproot, and several dichotomous branches; plants 6–8 cm tall (not including peduncles). Herbage white-woolly and aromatic. Leaves clustered near base of plant, alternate or sub-opposite, (1) 1.5–5.5 cm long, the blades narrowed to a winged petiole, oblanceolate, shallowly lobed to sharply toothed with coarse teeth. Flower heads raised well above the leaves on slender peduncles, with bright yellow disk florets. Phyllaries in outer and inner whorls, 6–7.5 mm long and woolly. Achenes 2.3–2.8 mm long and densely hairy; pappus of 5 broad scales divided into many uneven, slender, white to golden bristles, the scales thickened basally into a yellow callosity. Mostly growing and flowering November–April or May, occasionally flowering with summer-fall rains if the plants survive the pre-summer drought.

Widespread in Cabeza Prieta and Tinajas Altas, mostly in rocky or gravelly soils; desert flats, bajadas, rocky slopes, washes, and locally in arid granitic and limestone hills and bajadas in the southwestern part of Organ Pipe.

Mojave and Sonoran deserts in western Arizona, California, Nevada, both Baja California states, and northwestern Sonora.

OP: 1.5 mi N of Bonita Well, 9 Apr 1941, *McDougall 58*. Rocky slopes along Puerto Blanco Drive, 12 Apr 1978, *Bowers 1261* (ORPI). W end Puerto Blanco Mts, 14 Mar 2003, *Rutman 2003-316* (ORPI).

CP: Cabeza Prieta Tank, 6 Apr 1979, *Lehto L23529* (ASU). Camino del Diablo, 9 mi W of Visitor Center turnoff, 20 Mar 1979, *Yatskievych 79-228*. 1 mi W of Tule Well, 17 Apr 1983, *Hodgson H-2084* (DES). Tule Mts, 2 Feb 1992, *Felger 92-57*. Sheep Mt, 20 Mar 1992, *Harlan 56*. W Pinta Sands, 15 Sep 1992, *Felger 92-776*.

TA: Tinajas Altas, *Van Devender 10 Mar 1986*.

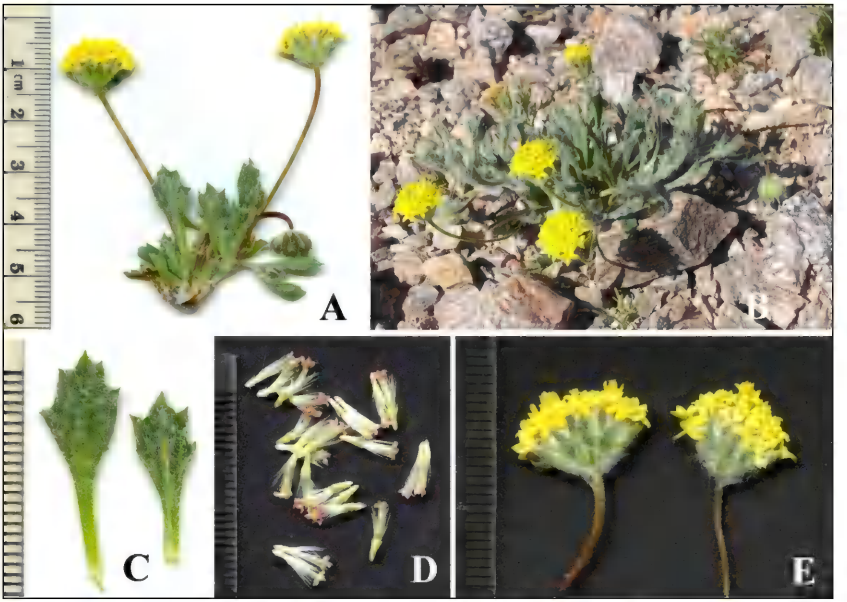

Figure 109. *Trichoptilium incisum*. (A & C) Above Quitobaquito Springs, 25 Feb 2015. (B) Quitobaquito Hills, 4 Feb 2005. (D & E) Sierra del Águila near Mex Hwy 2 at km marker 93, Sonora, 7 Mar 2015.

Trixis – Threefold

North America to South America, and West Indies; 65 species. Mutisieae.

Trixis californica Kellogg var. **californica**

California threefold. Figure 110.

Small shrubs often 50–75+ cm tall with erect-ascending, slender, brittle branches; new growth glandular and often densely pubescent with brown hairs. Plants ultimately leafless in drought and sometimes the branches die back; new growth frost sensitive. Leaves mostly (2.5) 3–8 cm long, mostly upright (ascending), sessile or petioles mostly 1–2 mm long and winged; leaf blades relatively thin, lanceolate, with minute hairs or sometimes glabrate, densely glandular especially on the lower surfaces, stomata usually on lower leaf surfaces only; leaf margins toothed to nearly entire; dry leaves semi-persistent. Flower heads in terminal clusters; florets bilabiate (2-lipped), yellow, 1 cm long.

Achenes 8–10 mm long, with a short, slender neck, the apex expanded into a disk bearing numerous soft, barbellate pappus bristles. Flowering and growing at various seasons, especially spring.

Widespread and common across the region including rocky slopes of hills and mountains often to the peaks, and bajadas, washes, and canyons. It has ranged across the flora area for at least 11,000 years.

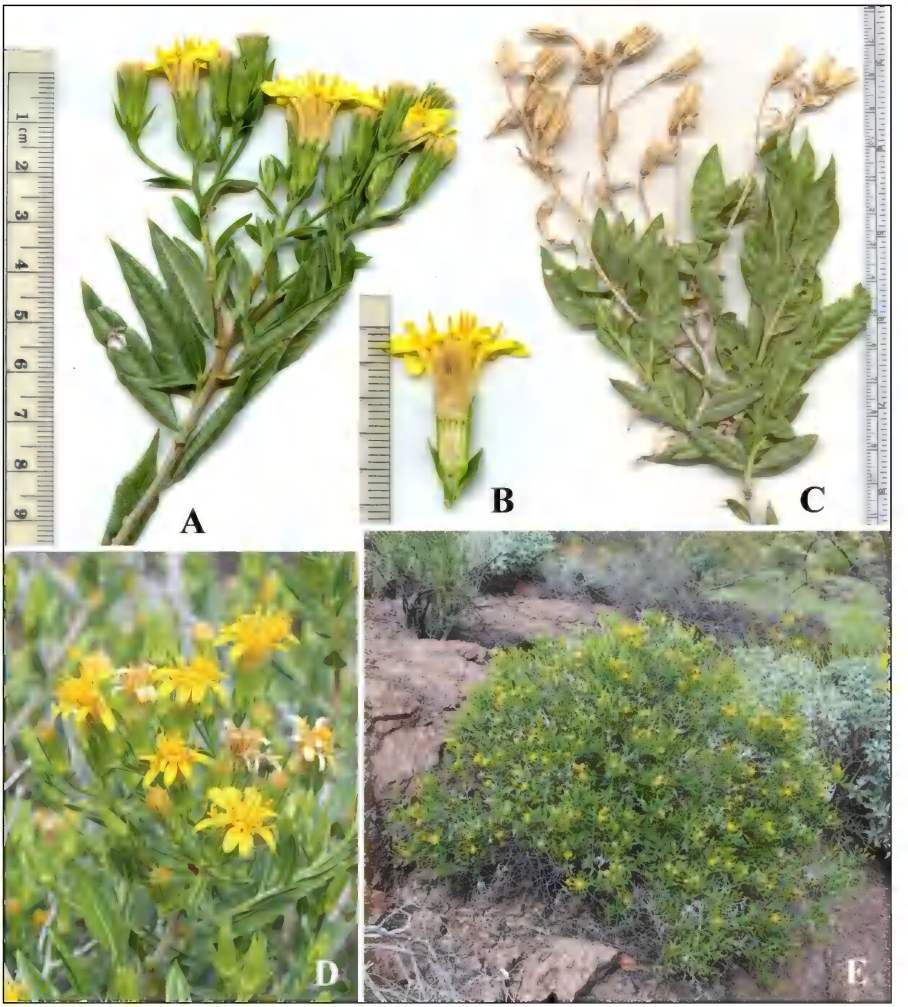

Figure 110. *Trixis californica* var. *californica*. (A, B, D, & E) Near Dripping Springs, 12 Mar 2015. (C) Branch with persistent involucres, Alamo Canyon, 10 Sep 2008.

Southeastern California to western Texas and northern Mexico. Seri women drank an infusion of this plant to hasten birthing, and the leaves were smoked like tobacco (Felger & Moser 1985).

Variety *californica* is unique among at least the North American members of *Trixis* in having stomata on both surfaces of the leaves. This feature seems to be part of a character set involving ascending rather spreading leaves, which is probably an adaptation to an arid or semi-arid environment. Variety *peninsularis* (S.F. Blake) C. Anderson, endemic to the Cape Region of Baja California Sur, is pubescent and has stomata restricted to the lower leaf surface.

OP: Quitobaquito: *Nichol 28 Apr 1939*; 14 Sep 1988, *Felger 88-457*. Victoria Pass, 8 Apr 1941, *McDougall 56*. Growler Mts, 24 Apr 1942, *Cooper 612*. Arch Canyon, 3500 ft, 28 Mar 1965, *Lockwood 162*. †Alamo Canyon, leaf fragments, 8590 & 9570 ybp. †Puerto Blanco Mts, on ridge, leaf fragments, modern (30) to 3440 ybp (4 samples).

CP: Tule Tank, *Hinkley 26 Mar 1932*. Agua Dulce Pass, 14 Apr 1964, *Niles 351*. Buck Mt Tank, 28 Mar 1970, *Duncan 14*. 5.6 mi E of Tule Well, 9 Mar 1980, *Reichenbacher 470*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: Tinajas Altas, *Vorhies 16 Apr 1924*. Tinajas Altas Pass, 4 mi W of Tinajas Altas, 17 Mar 1980, *Webster 24257*. †Butler Mts, leaf fragments, 740 to 8160 ybp (3 samples). †Tinajas Altas, leaf fragments, 4010 to 10,950 ybp (7 samples).

Uropappus

This genus has a single species. Cichorieae.

Uropappus lindleyi (de Candolle) Nuttall

[*Microseris lindleyi* (de Candolle) A. Gray. *M. linearifolia* (Nuttall) Schultz Bipontinus. *Uropappus linearifolia* Nuttall]

Silver puffs. Figure 111.

Spring ephemerals with milky sap. Leaves in a basal rosette, mostly 10–15 cm long, linear to linear-lanceolate or pinnate with a few slender segments, glabrate or moderately pubescent with crinkled white hairs near the leaf base. Stems 12–30 cm long, leafless, erect, with small glands near the flower head, each stem bearing a single, erect dandelion-like flower head. Phyllaries graduated, overlapping, the inner ones 15–30 mm long, broadly lanceolate. Heads ligulate, the florets ray-like, many, and pale yellow. Achenes 8.7–10 mm long, blackish, linear-cylindrical, and slightly tapered at each end, the apex slightly flared; pappus of 5 papery, silvery, linear-lanceolate scales 9–10 mm long, these deeply notched at the apex with a long, slender awn from the notch. The common name derives from the rounded head of achenes with their silvery-papery pappus bristles.

In the eastern part of Cabeza Prieta and widespread in Organ Pipe; washes, bajadas, canyons, and slopes including higher elevations.

Washington and Idaho to Baja California and Baja California Sur, northern Sonora, and Texas. The flowers are notably inconspicuous but the mature, achene-bearing heads are conspicuous.

OP: Alamo Canyon, 16 Apr 1941, *McDougall 98*. Arch Canyon, 28 Mar 1965, *Niles 544*. Boundary on Darby Well Road, 12 Mar 1983, *Daniel 2638* (ASU). 1 mi S of Pinkley Peak, 1960 ft, 2 Mar 1985, *Van Devender 85-7*. Ridge crest on trail to Mt Ajo, 4090 ft, 10 Apr 2005, *Felger*, observation.

CP: San Cristobal Wash, 20 Mar 1992, *Harlan 34* (CAB). Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-352*. Childs Mt, 9 Apr 1993, *Felger 93-290*. Near E boundary of Refuge on Charlie Bell Road, 9 Apr 1993, *Felger 93-328*.

Figure 111. *Uropappus lindleyi*. (A) Near Monkey Face, North Puerto Blanco Mts, 15 Mar 2015. (B) S fork of Alamo Canyon, 12 Mar 2005. Estes Canyon: (C) 3 Apr 2010; (D) 18 Mar 2005.

Verbesina

North America, mostly warm-temperate to tropical regions; 200+ species. Heliantheae, Ecliptinae.

****Verbesina encelioides** (Cavanilles) Bentham & Hooker f. ex A. Gray
[*V. encelioides* var. *exauriculata* B.L. Robinson & Greenman]
Golden crownbeard, cow-pen daisy. Figure 112.

Coarse, foul-smelling, non-seasonal ephemerals, occurring during warmer months. Herbage and phyllaries with coarse white hairs. Leaves opposite below, alternate above, gray-green to whitish, and bicolored. Petioles prominent; larger leaves with stipule-like leafy appendages (auricles) near the petiole base, the blades mostly 3–7 cm long, more or less ovate to triangular, and coarsely toothed. Flower heads yellow, daisy-like and showy, 3.5–5 cm wide, with ray and disk florets; most ray corollas cleft into 3 conspicuous terminal lobes. Disk achenes enclosed in chaffy bracts. Pappus none on ray achenes, of 1 or 2 short awns on disk achenes.

The single record in the flora area is from Quitobaquito when it was occupied and being farmed. It is a common urban and agricultural weed in adjacent Sonora and nearby areas in Arizona. It does not seem to be native to southwestern Arizona and northwestern Sonora.

Widespread and often weedy in the United States and Mexico, the Caribbean, and South America; widely naturalized in the Old World. Plants with leaf auricles have been called var. *exauriculata*.

OP: Quitobaquito, 30 Nov 1939, *Harbison 26271* (SD).

Figure 112. *Verbesina encelioides*. (A) La Aduana, near Alamos, Sonora, 8 Apr 2005. (B & C) Portal–Paradise Road, Chiricahua Mts, Cochise Co., 24 Aug 2013. Photos by Sue Carnahan.

Viguiera parishii, see **Bahiopsis parishii**

Xanthisma – Goldenweed

Annuals or ephemerals and small herbaceous perennials. Leaves with marginal bristles. Flower heads with bright yellow disk and ray florets. Achenes dimorphic (ray and disk achenes different); pappus of many coarsely barbellate bristles.

Western North America and Mexico; 17 species. Astereae.

1. Annuals or ephemerals, the involucres without glands…… **Xanthisma gracile**
1. Perennials and also flowering in first season or year; involucres glandular.
…….. **Xanthisma spinulosum**

Xanthisma gracile (Nuttall) D.R. Morgan & R.L. Hartman
[*Dieteria gracilis* Nuttall. *Haplopappus gracilis* (Nuttall) A. Gray. *Machaeranthera gracilis* (Nuttall) Shinners. *Haplopappus ravenii* R.C. Jackson]
Slender goldenweed. Figure 113.

Annuals or ephemerals, growing and flowering during warmer months with sufficient moisture, usually less than 30 cm tall. First leaves in a basal rosette and withering by flowering time, leaves reduced above; leaves obovate to oblanceolate, oblong, or linear, pinnatifid with white marginal bristles. Involucres hemispheric, 6–8 mm long; ray and disk florets bright yellow. Achenes 1.5–2.5 mm long; pappus bristles 4–5 mm long. Resembling *X. spinulosum* but the plants generally smaller and somewhat more delicate.

Organ Pipe at least in the vicinity of the Ajo, Bates, Diablo, and Growler mountains; washes, canyons, bajadas, and sometimes on rocky slopes.

Semi-arid regions of southwestern United States and northwestern Mexico; not in the drier regions of the Sonoran Desert. This species has the lowest chromosome number of any flowering plant ($n = 2$, some have $n = 3$ or 4).

OP: Bates Mts, 8 mi S of Growler Well, 1300 ft, *Nichol 17 Apr 1939*. Bull Pasture Trail, 2400 ft, 9 May 1979, *Bowers 1698*.

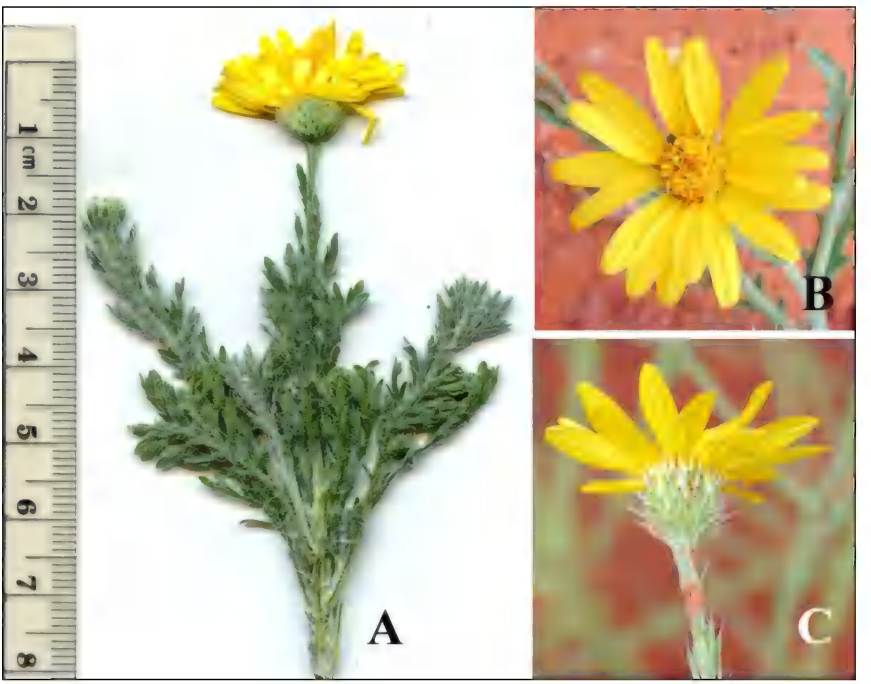

Figure 113. *Xanthisma gracile*. (A) Road to Kitt Peak, 0.5 mi from Hwy 85, 16 Apr 2015. (B) 0.5 mi W of Marble Mountain, Sikort Chuapo Mts, NE of Ajo, 14 Apr 2008, photo by Hank Jorgenson. (C) Sedona, Yavapai Co., 17 Apr 2001, photo by Max Licher (SEINet).

Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartman var. **gooddingii** (A. Nelson) D.R. Morgan & R.L. Hartman
[*Haplopappus spinulosus* (Pursh) de Candolle subsp. *gooddingii* (A. Nelson) H.M. Hall. *Machaeranthera pinnatifida* (Hooker) Shinners var. *gooddingii* (A. Nelson) B.L. Turner & R.L. Hartman]
Spiny goldenweed. Figure 114.

Figure 114. *Xanthisma spinulosum* var. *gooddingii*. Ajo roadside: (A) 22 Apr 2003; (B & C) 6 May 2006. (D) Bedrock hill N of Charlie Bell Pass, 16 Mar 2015.

Herbaceous perennials to 50+ cm tall, also flowering in the first season; the plants and flower heads highly variable in size. Herbage stipitate-glandular. Leaves 1- or 2-times pinnatifid, lobes mostly linear, the leaves often not markedly reduced above. Involucres 15–25 cm wide; phyllaries

glandular. Flower heads mostly single on short to long stems. Ray and disk florets bright yellow, flowering mostly in spring but also other seasons including with summer rains. Achenes 2 mm long; pappus bristles 4–6 mm long. $n = 4, 8$.

Widespread and common across the region, mostly among rocks on slopes, often to the summits of the drier mountains, bajadas, and sometimes along washes and on desert plains. This or a similar goldenweed was apparently common in the Tinajas Altas Region during the last 11,300 years.

Variety *gooddingii* occurs from Nevada and Utah to northwestern Sonora and Baja California. This highly polymorphic species complex, with seven recognized geographic varieties, ranges from central Mexico and Baja California Sur to Montana, North Dakota, and adjacent Canada.

OP: 8 mi S of Growler Well, *Nichol 17 Apr 1939*. Bates Well, 18 Nov 1939, *Harbison 26157* (SD). West Gate, 24 Apr 1942, *Cooper 554*. Bull Pasture trail, 9 May 1979, *Bowers 1697*.

CP: Tule Tank, 4 Dec 1934, *Goodding 2144*. Heart Tank, *Simmons 22 Apr 1965*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3932*. 4.7 mi E of Tule Well on Camino del Diablo, 11 Apr 1993, *Felger 93-441*. Sierra Pinta, summit, *Cain 15 Nov 2003*.

TA: 1 mi N of Tinajas Altas, 18 Apr 1948, *Kurtz 1169*. Tinajas Altas: Canyon in granite mts, 28 Oct 1937, *Gentry 3536*; *Van Devender 5 Mar 1983*. Borrego Canyon, 16 Jun 1992, *Felger 92-617*. †*Machaeranthera* cf. *pinnatifida*: Butler Mts, involucres, achenes, 740 to 11,250 ybp (7 samples); †Tinajas Altas, achenes, 4010 & 9900 ybp.

Zinnia

United States to Argentina; 17 species. *Zinnia angustifolia* and hybrids are popular garden plants. Heliantheae, Ecliptinae.

Zinnia acerosa (de Candolle) A. Gray

Desert zinnia; *zinia del desierto*. Figure 115.

Dwarf shrubs, mostly less than 25 cm tall. Herbage pubescent, scabrous, or glabrate. Leaves gray-green, often 1–2 cm long, linear to needle shaped. Flowers heads with 4–7 broad, persistent, white rays and about 8–12 yellow disk florets. Achenes 2.5–4 mm long; pappus with 1–3 awns or pappus vestigial. Flowering various seasons, especially April and May, and sometimes with summer rains.

Locally common in Organ Pipe except the western portion; bajadas and open rocky slopes.

Arizona to western Texas and southward to Sonora and Zacatecas, mostly in the Sonoran and Chihuahuan deserts.

OP: Walls Well, *Nichol 28 Apr 1939*. 0.5 mi N of Estes Canyon picnic ground [trailhead], 9 May 1979, *Bowers 1692*. Gunsight Hills, 2 Mar 2003, *Rutman 2003-208* (ORPI). Foothills of the Diablo Mts, 2476 ft, coarse colluvium, 22 Sep 2013, *Rutman 20130922-4*.

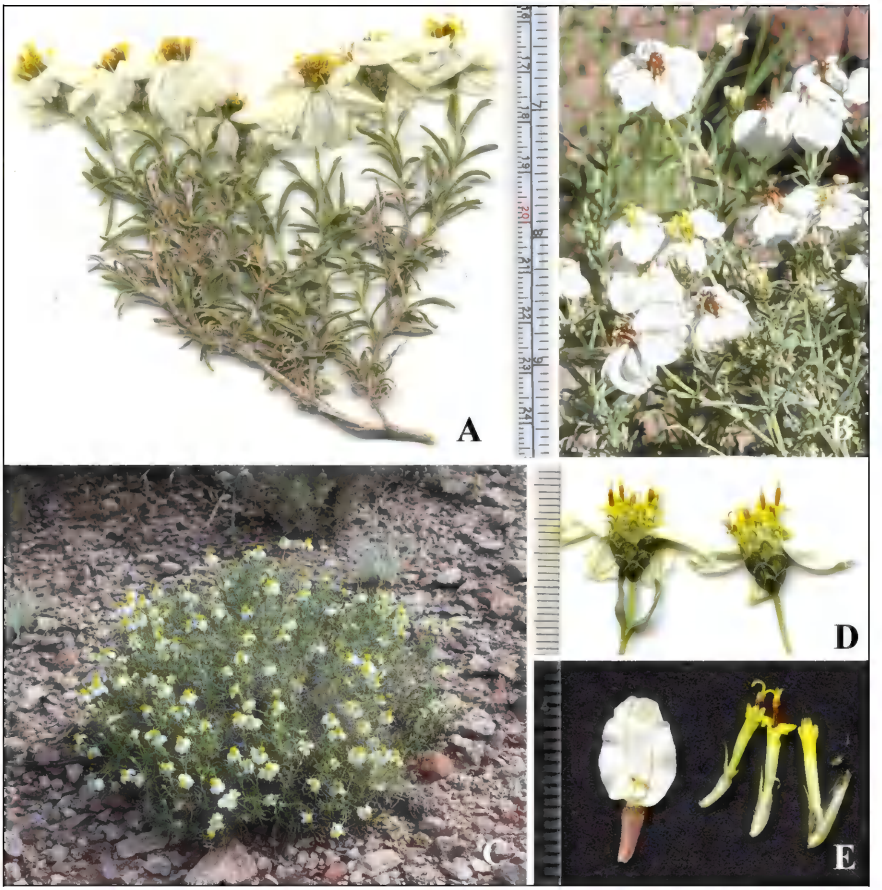

Figure 115. *Zinnia acerosa*. Foothills of Ajo Mts, Ajo Mountain Drive between Arch and Estes canyons: (A) 2 Mar 2008; (B) 30 Mar 2008; (C) 2 Aug 2013; (D & E) 22 Mar 2015.

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SPREAD OF THE INVASIVE RAVENNA GRASS (*TRIPIDIUM RAVENNAE*, POACEAE) IN OHIO

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ABSTRACT

Ravenna grass, *Tripidium ravennae,* an introduced ornamental grass from the Mediterranean region, is documented from 30 counties in Ohio. The species was first found in the state as an escape in Cuyahoga County in 2000, with further documentation from Hocking County in 2008, Butler County in 2009, and Greene County and Ross County in 2010. The species is being found with increasing frequency in recent years. It seems likely that the species will become problematic in marginal areas and grasslands in the near future.

Ravenna grass (also known as Plume-grass, *Tripidium ravennae* (L.) H. Scholz, Poaceae) is a very large popular ornamental species that is hardy through USDA Zone 6. Ravenna grass forms large clumps that are similar in appearance to Pampas grass (*Cortaderia sellloana* (Schultes & Schultes f.) Ascherson & Gräbner, which is hardy only to about USDA zone 8) and is grown in much the same setting (Bailey 1924; Darke 1999; Holmes 1997). Ravenna grass may also be utilized for erosion control and as a forage crop (Wiersema & León 2013).

Ravenna grass appears to be native to a broad swath of the Eastern Hemisphere, from the Mediterranean region of southern Europe, northern Africa, and western Asia, east into Asia through Afghanistan as far east as Xinjiang Province in China, south to Yemen and northern India, and north to the Republic of Georgia, Uzbekistan, and Kazakhstan (Chen & Phillips 2006; Pasiecznik 2015). In the Mediterranean region of northern Africa and southern Europe, it can form tall cane beds with other grasses along water courses and in damp depressions and behind dunes (Clayton 1980).

The nomenclatural history of Ravenna grass is complex. The species was first described by Linnaeus (1763) as *Andropogon ravennae* L.; the specific epithet refers to the town of Ravenna, Province of Ravenna, Emilia-Romagna region, northern Italy. He subsequently moved the species to the genus *Saccharum,* as *Saccharum ravennae* (L.) L. (Linnaeus 1774), a name which has been in common use since. Palisot de Beauvois (1812) made a new combination, *Erianthus ravennae* (L.) P. Beauv., followed soon after by a new combination in *Ripidium* (an illegitimate name, since it is a later homonym of *Ripidium* Bernhardi, published in 1800) by Trinius (1820), *Ripidium ravennae* (L.) Trin. Most recently, Scholz made the new combination *Tripidium ravennae* (L.) H. Scholz, since Old World species of *Erianthus* are distinct from New World species in chemical and molecular markers and in having three stamens instead of two (Valdés & Scholz 2006). The separation of *Tripidium* from *Saccharum* is supported by molecular phylogenetic studies of *Saccharum s. lat.* conducted by Welker et al. (2015).

Figure 1. Characteristic specimen of Ravenna grass.

Ravenna grass (Fig. 1). is a tall, erect, clump-forming herb that can reach ca. 4 m in height. The stems, nodes, and leaf sheaths and blades are glabrous. Obvious ligules of capillary bristles about 1 cm long can be seen in the junction of the blade and sheath. Leaf blades range from 50 to 120 by 5 to 18 mm wide, and have scabrous surfaces and margins, and a whitish midvein. The plumose inflorescences are borne on peduncles 40 to 80 cm long. The inflorescences are large, lanceolate, much-branched, villous panicles from 30 to 70 cm long and 10 to 20 cm wide. Spikelets are subtended by long hairs on the callus and are 3 to 6 mm long, with purplish to straw–colored glumes and 2 to 5 mm-long awns. The spikelets disarticulate from the rachis at maturity and are easily blown about by wind.

Ravenna grass has escaped in several countries where it has been grown as an ornamental, including Australia (Pasiecznik 2015), Japan (Shimura et al. 1973), and the USA (Barkworth et al. 2007; Webster 2003). In the USA, Ravenna grass has been reported as escaped or naturalized in at least 22 states and DC: Arizona (Kearney & Peebles 1960), California (Hickman 1993), Colorado (USDA NRCS 2016), Delaware (Tatnall 1946), District of Columbia (Steury 2004), Florida (Wunderlin & Hansen 2008), Georgia (Jones & Coile 1988), Illinois (Mohlenbrock 2001), Indiana (personal obs. RLG, MAV, K. Yatskievych), Kansas (McGregor et al. 1976), Kentucky (Jones 2005), Maryland (Terrell & Peterson 2009), Michigan (Reznicek et al. 2011), Missouri (Yatskievych 1999), New York (Lamont et al. 2014), New Mexico (Warrick 2000), Ohio (Wilder & McCombs 2002), Oklahoma (Taylor & Taylor 19889), Pennsylvania (specimen at MU), Tennessee (Chester 2009), Texas (Singhurst et al. 2010), Utah (Welsh et al. 1987), and Washington (Weinmann et al. 2002+); it is very likely also spreading in other regions of the country. In the USA, Ravenna grass is establishing in riparian wetland zones (Burgess & Hoagland 2006; Lambert et al. 2010; Winston et al. 2014) and also in drier areas, including rocky slopes, grasslands, fields, and roadsides (Winston et al. 2014). The species is considered a noxious weed in California (https://www.cdfa.ca.gov/plant/ipc/encycloweedia/weedinfo/winfo_table-sciname.html), New Mexico (http://www.nmda.nmsu.edu/wp-content/uploads/2012/01/weed_memo_list.pdf), Oregon (http://www.oregon.gov/ODA/shared/Documents/Publications/Weeds/NoxiousWeedPolicyClassification.pdf), and Washington (http://www.nwcb.wa.gov/pdf/Noxious%20weed%20list%202016_scientific%20name.pdf), and invasive in Pennsylvania (http://www.dcnr.state.pa.us/cs/groups/public/documents/document/ dcnr_010233.pdf) and Utah (Thomas 2012), and by the National Park Service (Briefel 2012).

Potential ecological impacts of Ravenna grass are likely to be similar to those of other large grasses, such as *Arundo donax* L. and non-native populations of *Phragmites australis* (Cav.) Trin. ex Steud. (Lambert et al. 2010), especially in wetland areas where these grasses might outcompete native wetland plants, and change water flow patterns. Populations of Ravenna grass may become large in wetland habitats, as has been seen in Arizona, especially along the Colorado River (Penn 2001), California (DiTomaso & Healy 2007), and Oklahoma, as can be seen along the Canadian River (Burgess & Hoagland 2006). It also spreads to drier, open sites, such as roadsides and fields (Swearingen et al. 2010).

Ravenna grass is very widely planted as an ornamental in Ohio, especially in newer housing developments. As a consequence, it is also escaping from cultivation with greater frequency and is establishing large populations in some areas. The first documented report of Ravenna grass as an escape in Ohio was from Cuyahoga County in 2000 by Wilder and McCombs (2002). It was subsequently documented from Greene, Hocking, and Ross counties by Vincent et al. (2011). The purpose of this study is to examine how widely Ravenna grass has escaped in Ohio.

Methods

Field surveys for Ravenna grass were conducted randomly throughout the state of Ohio, especially in the vicinity of planted populations of the grass. Each population discovered was documented either by a voucher specimen or as a visual record. Specimens were deposited in

herbaria indicated with each specimen record, and additional specimens were examined from Ohio herbarium collections (see Specimens Examined).

Results and discussion

Escapes or populations were documented (or observed*) from 30 counties in Ohio (Fig. 2; see Specimens Examined): Adams, Athens, Butler, Champaign, Clark, Clermont, Cuyahoga, Delaware, Erie, Fairfield, Franklin, Greene, Hamilton, Hancock, Hocking, Lucas, Madison, Medina, Miami*, Montgomery, Ottawa, Pickaway, Pike, Ross, Scioto, Stark, Summit, Union, Warren, and Wayne. The grass occurs on roadside lawns, steep, grassy road banks, abandoned limestone quarries, railroad ballast, old fields, prairie plantings, marshy areas, and waste places. Currently, all sites are disturbed secondary habitats, but Ravenna grass also may invade natural habitats such as tall grass prairies, xeric limestone prairies, alvars, savannahs, and wet meadows. Populations in the Columbus metropolitan area (Delaware, Fairfield, Franklin, Madison, and Union counties) appear to be increasing numbers in the last 5 years, with at least 18 sites documented (Fig. 3).

Ravenna grass has great invasive potential in Ohio. Since it is widely and commonly planted as a landscape plant, and since it produces a large number of fruits on each plant, is will be found more and more commonly as an escape in Ohio. Wild plants are capable of setting large numbers of fruits, thus increasing the spread of the species. Continued monitoring of the spread of Ravenna grass is warranted, as is removal of the species in wild populations where it is found.

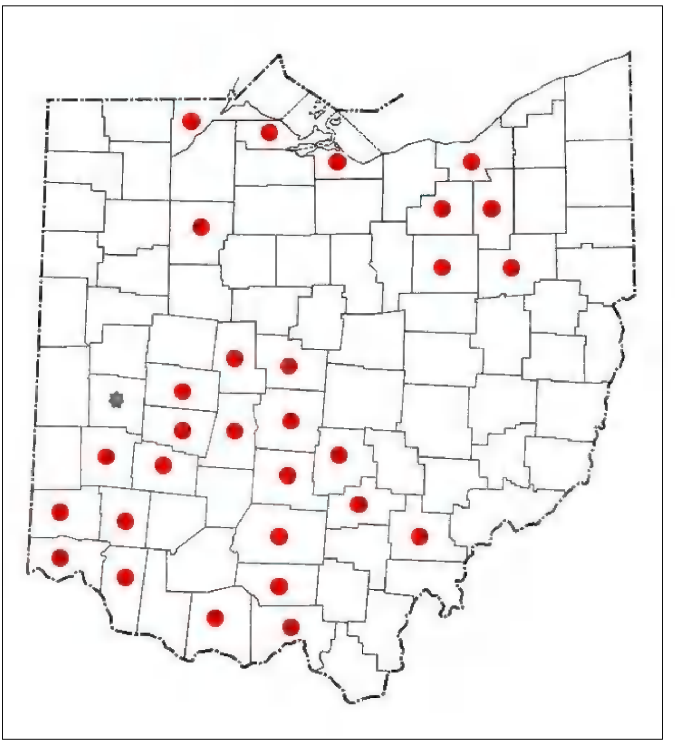

Figure 2. County-level distribution of Ravenna grass in Ohio.

Figure 3. Distribution of Ravenna grass in the Columbus metropolitan area (Delaware, Fairfield, Franklin, Madison, and Union counties).

Specimens examined

Ohio. Adams Co.: Tiffin Twp., 1 fruiting clump in disturbed field, W of St. Rte. 125, ca. 0.25 mi S of entrance to Adams Lake State Park, 20 Sep 2013, *Gardner 7300* (MU). Athens Co.: York Twp., one 3-stemmed fruiting clump on roadside, St. Rte. 78, ca. 500 ft N of Monday Creek, 12 Nov 2015, *Gardner 7373* (MU); York Twp., 21-30 plants along roadside ditch, St. Rte. 78, 50 ft W of 12th St., 12 Nov 2015, *Gardner 7372* (MU). Butler Co.: Liberty Twp., 1 plant on steep, dry road bank E-bound St. Rte. 129, 31 Aug 2013, Gardner 7282 (MU); Middletown, weedy marshy area near 4900 Roosevelt Blvd., 14 Nov 2012, *Vincent 16010* (MO, MU, NY); Oxford, Miami University campus, weedy in a clump of *Miscanthus sinensis* planted by Upham Hall greenhouse, 27 Aug 2009, *Vincent 14558* (MU). Champaign Co.: Mad River Twp., NE ¼ Sec. 35, 1 clump on roadside across from Myrtle Tree Baptist Church, U.S. Rte. 36 E of St. Paris, Sep 2013, *Boone s.n.* (MU). Clark Co.: Harmony Twp., Section 18, 1 flowering plant, dry roadside bank on west bound I-70, 30 Aug 2013, *Gardner 7280* (MU). Clermont Co.: Union Twp., roadside, St. Rte. 32, 1.6 mi E of Newtown, 2 Sep 2013, *Boone s.n.* (MU); Withamsville, weedy in wet ditch along Rte. 125 E of Glen-Este-Withamsville Rd., 2 Sep 2013, *Vincent & M.W. Vincent 16590* (MU). Cuyahoga Co.: Cleveland, along RR tracks, Cleveland Metroparks Zoo, 18 Sep 2000, *Wilder & McCombs 14062* (SWF). Delaware Co.: Liberty Twp., S of Winter Road, 75-100 plants in planted prairie, ca. 0.25 mi W of U.S. Rte. 23, 14 Sep 2013, *Gardner 7298* (MU); Orange Twp., 2 multiple stem fruiting clumps, roadside, S-bound I-71 ca. 250 feet N of Gemini Place exit ramp, 5 Sep 2013, *Gardner 7286* (MU); Troy Twp., U.S. Rte. 23, N of Delaware, 1 fruiting clump in area where topsoil was removed, 7 Sep

2013, *Gardner 7288* (MU). Erie Co.: Groton Twp., 7 plants in old field, on E side of St. Rte. 4, ca. 0.2 mi N of Strecker Rd., 17 Sep 2013, *Gardner 7299* (MU). Fairfield Co.: Greenfield Twp., SE ¼ Section 7, 5 plants, 1 in flower, roadside E bound U.S. Rte. 33, 19 Sep 2016, *Gardner 7421* (MU). Franklin Co.: Clinton Twp., 3 plants on dry road bank, N. Broadway ca. 0.1 mi W of I-71, City of Columbus, 20 Sep 2013, *Gardner 7301* (MU); Hamilton Twp., 3 clumps on dry road bank, I-270 ca. 1 mi E from U.S. Rte. 23 interchange, Village of Obetz, 9 Sep 2013, *Gardner 7296* (MU); Jackson Twp., S bound entrance ramp from Stringtown Rd., ca. 75 plants on dry, WSW-facing road bank, 7 Sep 2013, *Gardner 7295* (MU); Sharon Twp., 1 fruiting clump, S-bound I-71 just N of 1-270 interchange, 5 Sep 2013, *Gardner 7288* (MU). Greene Co.: Bath Twp., NE ¼ Section 28, occasional in dry, limestone field, Wright-Patterson Air Force Base, 7 Sep 2010, *Gardner 6987* with Becus & Helton (OS). Hamilton Co.: Cincinnati, weedy along N side of U.S. Rte. 50 at Collins Ave. bridge, 2 Sep 2013, *Vincent & M.W. Vincent 16589* (MICH, MU, NY); Whitewater Twp., 8 plants on steep, W-facing slope, St. Rte. 128/I-75 E bound entrance ramp, 30 Aug 2013, *Gardner 7281* (MU). Hancock Co.: Allen Twp., NE ¼ Section 1, local, 5 plants, disturbed soil near burrow pit pond few feet W of Business Park Drive (Twp. Rte. 114) & S. of St. Rte. 18, 12 Dec 2013, *Gardner 7315* (MU). Hocking Co.: Falls Twp., Section 13, rare, abandoned railroad yard, N. of U.S. Rte. 33, 10 Sep 2008, *Gardner 6055* (OS). Falls Twp., Section 15, E of N-bound U.S. Rte. 33, S of exit, rare, a few on a road cut, 18 Sep 2008, Gardner 6061 (OS). Good Hope Twp., NW ¼ NW ¼ Section 23, 1 large multi-stem clump, planted prairie, N of U.S. Rte. 33, 6 Oct 2016, *Gardner 7425* (MU). Lucas Co.: Springfield Twp., a few clumps on both sides of I-475, 12 Dec 2013, *Gardner 7314* (MU). Madison Co.: Somerford Twp., 1 clump on N-facing roadbank, E-bound entrance ramp, I-70, St. Rte. 56 jct., 24 Oct 2016, *Gardner 7427* (MU). Medina Co.: Guilford Twp., ca. dozen clumps on dry road bank W-bound I-76, St. Rte. 3, 31 Oct 2013, *Gardner 7313* (MU). Montgomery Co.: Huber Heights, 20-30 clumps in weedy ditch along Interstate 70 westbound, 14 Sep 2013, *Vincent & M.W. Vincent 16591* (GH, MU, NY). Ottawa Co.: Danbury Twp., half dozen plants in planted prairie, N of Bay Shore Rd., Meadowbrook Park, 27 Sep 2016, *Gardner 7422* (MU). Pickaway Co.: Walnut Twp., Section 26, 3 plants (2 fruiting, 1 vegetative) in dry field adjacent to golf course, Hagerty Rd., 29 Aug 2013, *Gardner 7279* (MU); Washington Twp., SW ¼ Section 28, 1 fruiting clump on gravel bank above stream, St. Rte. 56 near Hitler Road #1 jct., 29 Aug 2013, *Gardner 7278* (MU). Pike Co.: Camp Creek Twp., 2 fruiting clumps in planted *Sorghastrum nutans* field, ca. 1000 ft N of Pike/Scioto Co. line, <250 ft W of St. Rte. 104, 7 Sep 2013, *Gardner 7291* (MU); Pee Pee Twp., SW of jct. of St. Rte. 104 & St. Rte. 552, 1 large clump with *Salix* sp. and *Solidago altissima* on rocky shore of Lake White, 7 Sep 2013, *Gardner 7292* (MU). Ross Co.: Scioto Twp., Section 20, local, a few clumps, roadside, U.S. Rte. 23 at U.S. 50 exit, City of Chillicothe, 28 Sep 2010, *Gardner 6998* (OS). Scioto Co.: Nile Twp., 1 fruiting clump in open meadow near golf course at Shawnee State Park, <100 ft S of U.S. Rte. 52, W. of Friendship, 7 Sep 2013, *Gardner 7293* (MU). Stark Co.: Perry Twp., 6 plants, 4 fruiting clumps, roadside/fence line W-bound U.S. Rte. 30, 29 Sep 2013, *Gardner 7312* (MU). Summit Co.: Richfield Twp., one 2-stemmed clump at base of road cut, edge of ditch, I-271 N-bound, ca. 0.5 mi S of St. Rte. 303 exit, 4 Sep 2013, *Gardner 7285* (MU). Union Co.: Jerome Twp., one 4-stemmed fruiting clump in prairie planting, Hyland-Croy Road at jct. with McKitrick Rd., 15 Nov 2015, *Gardner 7374* with Lapp (MU). Warren Co.: Clear Creek Twp., one several-stemmed fruiting clump, at fence line S of Austin Blvd., N-bound I-75, 31 Aug 2013, *Gardner 7283* (MU); Turkey Creek Twp., one fruiting clump, roadside ditch, St. Rte. 123 across from Red Bird Drive, 19 Oct 2014, *Gardner 7334* (MU). Wayne Co.: East Union Twp., 1 fruiting clump roadside E-bound U.S. Rte. 30 near Kansas Rd. exit ramp, 28 Sep 2013, *Gardner 7309* (MU).

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NOMENCLATURAL NOTES ON NORTH AMERICAN TAXA OF *ANEMONASTRUM* AND *PULSATILLA* (RANUNCULACEAE), WITH COMMENTS ON THE CIRCUMSCRIPTION OF *ANEMONE* AND RELATED GENERA

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ABSTRACT

A pragmatic circumscription of *Anemone* L. and related genera of Ranunculaceae is discussed based on recent molecular phylogenetic results and traditional taxonomy. It is concluded that the monophyletic taxonomy of *Anemone* sensu lato can be achieved only by inclusion in *Anemone* of such readily recognized and morphologically distinguishable genera as *Clematis* L., *Hepatica* Mill., *Pulsatilla* Mill., and some others, which is hardly a practical approach. An alternative option, which is preferred here, is the recognition of several genera segregated from *Anemone* sensu lato. The taxa placed in *Anemone* in the *Flora of North America North of Mexico* should be now placed in at least four genera: *Anemone* sensu stricto, *Hepatica*, *Pulsatilla*, and *Anemonastrum* Holub (incl. *Anemonidium* (Spach) Holub, *Arsenjevia* Starod., *Tamuria* Starod., and *Jurtsevia* Á. Löve & D. Löve). New nomenclatural combinations for North American and some other taxa of *Anemonastrum* are validated: **Anemonastrum** sect. **Anemonidium** (Spach) Mosyakin, **comb. nov.** (*Anemone* sect. *Anemonidium* Spach), **Anemonastrum** [sect. *Anemonidium*] subsect. **Anemonidium** (Ulbr.) Mosyakin, **comb. nov.**, **Anemonastrum** [sect. *Anemonidium*] subsect. **Richardsonia** (Ulbr.) Mosyakin, **comb. nov.** (*Anemone* ser. *Richardsoniae* Ulbr.), **Anemonastrum canadense** (L.) Mosyakin, **comb. nov.** (*Anemone canadensis* L.; *Anemonidium canadense* (L.) Á. Löve & D. Löve), **Anemonastrum dichotomum** (L.) Mosyakin, **comb. nov.** (*Anemone dichotoma* L., *Anemonidium dichotomum* (L.) Holub), and **Anemonastrum richardsonii** (Hook.) Mosyakin, **comb. nov.** (*Anemone richardsonii* Hook., *Anemonidium richardsonii* (Hook.) Starod., *Jurtsevia richardsonii* (Hook.) Á. Löve & D. Löve). Three varieties of *Anemone narcissiflora* recognized in the *Flora of North America North of Mexico* are better accepted as three species: *Anemonastrum sibiricum* (L.) Holub, *A. villosissimum* (DC.) Holub, and *A. zephyrum* (A. Nelson) Holub. The North American taxon of the *Pulsatilla patens* (L.) Mill. group is recognized as a separate species *P. nuttalliana* (DC.) Bercht. & J. Presl; its nomenclature and synonymy are discussed and updated.

The phylogenetically natural and taxonomically rational circumscription of the genus *Anemone* L. and related taxa of Ranunculaceae Juss. tribe Anemoneae DC. is a long-debated issue. In particular, the genera *Hepatica* Mill., *Pulsatilla* Mill., *Knowltonia* Salisb., *Barneoudia* Gay, *Oreithales* Schltdl. (= *Capethia* Britton) and some others were readily recognized in many earlier and some recent taxonomic treatments (Britton 1892; Juzepczuk 1937; Steyermark & Steyermark 1960; Rasmussen 1979; Duncan & Keener 1991; Starodubtsev 1991; Tamura 1993; 1995; Tzvelev 2001, 2012; Malyshev 2005 etc.). In addition to those taxa, several other genus-level segregates of *Anemone* were proposed and/or recognized, such as *Anemonastrum* Holub, *Anemonidium* (Spach) Holub, *Anemonoides* Mill., *Arsenjevia* Starod., *Eriocapitella* Nakai, *Jurtsevia* Á. Löve & D. Löve, *Pulsatilloides* (DC.) Starod., *Tamuria* Starod. (Holub 1973, 1974; Starodubtsev 1991, 1995; Czerepanov 1995, Uotila 2001; Tzvelev 2001, 2012; Malyshev 2012 etc.), but their acceptance was more limited.

At present, following recent molecular phylogenetic results (Hoot & Palmer 1994; Hoot & al. 1994, 2012; Ehrendorfer 1995; Hoot 1995; Ehrendorfer & Samuel 2001; Schuettpelz & al. 2002; Wang & al. 2009; Meyer & al. 2010; Zhang & al. 2015b etc.), the genus *Anemone* is usually accepted in a wide sense, including all or almost all genera mentioned above. According to the recent taxonomic treatment heavily based on molecular phylogenetic patterns (Hoot & al. 2012), *Anemone* in the wide sense includes two subgenera, subg. *Anemonidium* (Spach) Juz. and subg. *Anemone*. Four sections are recognized in each subgenus: (1) sect. *Hepatica* (Mill.) Spreng., (2) sect. *Keiskea* Tamura, (3) sect. *Anemonidium* Spach, and (4) sect. *Omalocarpus* DC. [with subsect. *Omalocarpus* (DC.) Tamura and subsect. *Himalayicae* (Ulbr.) Tamura] in subg. *Anemonidium* and (1) sect. *Pulsatilloides* DC. (with 8 subsections), (2) sect. *Pulsatilla* (Mill.) DC., (3) sect. *Rivularidium* Jancz., and (4) sect. *Anemone* (with 6 subsections) in subg. *Anemone*. As a result of molecular phylogenetic studies, new combinations in *Anemone* were proposed for taxa earlier placed in *Knowltonia* (Manning & al. 2009) and *Pulsatilla* (Jiang & al. 2015), as well as some new combinations for infrageneric taxa (Hoot & al. 2012).

However, other molecular phylogenetic results and morphological data allow alternative phylogenetic patterns and different taxonomic solutions (Pfosser & al. 2011). The most important issue unresolved until recently was the proper phylogenetic placement of the large (ca. 250–300 species) and diverse genus *Clematis* L., position of which in some phylogenetic studies was controversial, either as sister to *Anemone* sensu lato or rooted in it. The new molecular phylogenetic results (Lehtonen & al. 2016) convincingly indicate that the clade of *Clematis* (incl. *Atragene* L.) and *Anemoclema* (Franch.) W.T. Wang (Wang 1964; Zhang & al. 2015; often treated earlier as *Anemone* subgen. *Anemoclema* (Franch.) Tamura or sect. *Anemoclema* Franch.: see Tamura 1995; Ziman & al. 2008, etc.) is in fact rooted in the grade of *Anemone* sensu lato (in the circumscription proposed by Hoot & al. 2012). In particular, Lehtonen & al. (2016) concluded that "*Anemone s.l.* is paraphyletic to *Anemoclema* + *Clematis*" and that "paraphyly of *Anemone s.l.* was strongly supported and evident under all studied parameter costs." They further commented that "an often assumed monophyly of a broadly defined *Anemone s.l.* apparently is an artefact caused by erroneous outgroup selection and poor sampling of non-focal groups." (Lehtonen & al. 2016: 840).

RATIONAL GENUS-LEVEL TAXONOMY OF *ANEMONE* SENSU LATO: A MODEST PROPOSAL

In view of new data it should be concluded that a monophyletic taxonomy of *Anemone* sensu lato can be achieved only by inclusion in *Anemone* of such readily recognized and morphologically distinguishable genera as *Clematis*, *Hepatica*, *Pulsatilla* and some others, which is hardly a practical approach, since the addition of *Clematis* to *Anemone* will require hundreds of new taxonomic combinations and possible new names. Moreover, both *Anemone* sensu lato and *Clematis* contain many important cultivated taxa and excessive changes in their nomenclature are not desirable.

An alternative option, which is strongly preferred here, is the recognition of several genera segregated from *Anemone* sensu lato. In my opinion, the following genera can be recognized, based on the clades revealed in Hoot & al. (2012) and in other molecular phylogenetic studies (Schuettpelz & al. 2002; Wang & al. 2009; Meyer & al. 2010; Zhang & al. 2015b etc.) as well as on some of the morphologically outlined groups (infrageneric taxa or segregate genera) recognized in recent taxonomic treatments (Starodubtsev 1991, 1995; Tamura 1993, 1995; Luferov 2001; Wang & al. 2001; Ziman & al. 2004, 2005, 2006a, 2006b, 2007, 2008, 2009, 2013; Ehrendorfer & al. 2009; Manning & al. 2009; Manning & Goldblatt 2013; Zhang & al. 2015b etc.).

1. *Hepatica* Mill.
2. *Anemonastrum* Holub in an expanded circumscription (including genera *Anemonidium*, *Arsenjevia*, *Jurtsevia*, and *Tamuria*), housing taxa placed by Hoot & al. (2012) in *Anemone* sect. *Keiskea*, sect. *Anemonidium*, and sect. *Omalocarpus*.

3. *Knowltonia* Salisb. (most probably the earliest available generic name applicable to this group) in a greatly expanded circumscription, corresponding to *Anemone* subg. *Anemone* sect. *Pulsatilloides* sensu Hoot & al. (2012) (including the genera *Barneoudia*, *Oreithales*, and *Pulsatilloides*).
4. *Pulsatilla* Mill. (including *Miyakea* Miyabe & Tatew.).
5. *Anemone* L. sensu stricto (including genera *Anemonoides*, *Anemonanthea* (DC.) Gray etc.).
6. *Anemoclema* (Franch.) W.T. Wang, the clade revealed as sister to *Clematis* (Zhang 2015a; Lehtonen & al. 2016), containing one morphologically distinct species, *Anemoclema glaucifolium* (Franch.) W.T. Wang (*Anemone glaucifolia* Franch., *Pulsatilla glaucifolia* (Franch.) Huth).

In any case, *Anemonastrum* is phylogenetically more distant from *Anemone* sensu stricto than *Pulsatilla* and *Knowltonia*, among others. It also differs from *Anemone* karyologically: *Hepatica* and *Anemonastrum* (revealed in most of molecular studies as sister groups) have the base chromosome number x=7, while the other genera have x=8.

It is not an unusual situation now when a widely recognized "traditional" genus is revealed, in view of new phylogenetic information, as a polyphyletic or paraphyletic group, which is exactly what happened to *Anemone*. Taxonomic solutions aimed at achieving monophyly of recognized genera in such cases vary widely –– from submerging of several genera into one genus sensu lato to splitting of "traditional" genera into monophyletic segregates, and/or to dramatic re-circumscriptions of genera. A relevant example is *Aloe* L. (Asphodelaceae subfam. Alooideae or Xanthorrhoeaceae subfam. Asphodeloideae) and its relatives. Recent phylogenetic studies of that group clearly demonstrated that both *Aloe* and *Haworthia* Duval, as traditionally circumscribed, are widely polyphyletic (Treutlein & al. 2003; Daru & al. 2013; Grace & al. 2013; Manning & al. 2014 etc.). Several taxonomic options were discussed, but finally a solution with recognition of several "narrow" genera corresponding to major clades has been proposed (Grace & al. 2013; Manning & al. 2014). Another relevant example is *Chenopodium* L. sensu lato (see overviews in: Fuentes & al. 2012; Hernández-Ledesma & al. 2015). Numerous additional examples of taxonomic handling of similar cases from the European flora are discussed in Kadereit & al. (2016).

In many cases, such large-scale taxonomic and especially nomenclatural changes are psychologically disturbing, at least for some plant taxonomists and mainly for non-taxonomists using the taxonomic information. However, gradually such changes are becoming widely accepted, especially if they are supported by solid phylogenetic evidence. I expect, for example, that the proposal to re-circumscribe the genus *Knowltonia* (the name that was traditionally applied only to a morphologically rather distinct group of southern African taxa characterized by fleshy fruits and much-branched inflorescences –– see Rasmussen 1979; Manning & al. 2009) to accommodate also the South American taxa earlier placed in genera *Barneoudia* and *Oreithales* plus some other taxa usually treated in several infrageneric groups of *Anemone* may cause some resistance or opposition, as happened with our earlier proposal to expand the limits of *Dysphania* R. Br. (the name earlier applied only to Australian taxa) to include all glandular-pubescent species of *Chenopodium* sensu lato occurring on almost all continents (Mosyakin & Clemants 2002, 2008; Clemants & Mosyakin 2003). However, at present the new concept of *Dysphania* is almost universally accepted, with some necessary minor adjustments (Fuentes & al. 2012; Uotila 2013; Hernández-Ledesma & al. 2015 etc.). Hopefully, the same will happen to the new concept of *Knowltonia* provisionally proposed here and to other re-circumscribed segregates of *Anemone*.

Main morphological characters and potential synapomorphies of the major clades of *Anemone* sensu lato were summarized by Hoot & al. (2012). More detailed discussion on diagnostic morphological characters is available from many recent taxonomic revisions of *Anemone* sensu lato (Starodubtsev 1991; Tamura 1993; Wang & al. 2001; Ziman & al. 2004, 2005, 2006a, 2006b, 2007,

2008, 2009, 2013; Ehrendorfer & al. 2009; Ren & al. 2009; Manning & al. 2009; Manning & Goldblatt 2013 etc.). New nomenclatural combinations and a more detailed morphological justification of the accepted genera and infrageneric taxa will be possible in parallel with the progress of an updated taxonomic revision of *Anemone* and related taxa now being prepared by Svetlana Ziman with several collaborators; they, however, at present prefer to keep *Anemonastrum* in *Anemone*, at the same time recognizing *Hepatica* and *Pulsatilla* as separate genera.

Meanwhile, I decided to propose here just a brief nomenclatural and taxonomic update to the treatment of *Anemone* in the *Flora of North America North of Mexico* (Dutton & al. 1997). The taxa placed in *Anemone* in that treatment should be now placed in at least four genera: *Anemone* sensu stricto, *Hepatica*, *Pulsatilla*, and *Anemonastrum*. *Hepatica* and *Pulsatilla* are accepted here in their traditional circumscription. I prefer an expanded circumscription of *Anemonastrum* as compared to the concept of this genus originally proposed by Holub (1973). The three groups corresponding to the clades recognized by Hoot & al. (2012) as sections of *Anemone* subg. *Anemonidium* can now be treated as sections of *Anemonastrum*. North American taxa belong to two sections, one of which can be further subdivided into subsections (see the new combinations below).

VALIDATION OF NEW COMBINATIONS

Anemonastrum Holub sect. **Anemonidium** (Spach) Mosyakin, **comb. nov.** *Anemone* sect. *Anemonidium* Spach, Hist. Nat. Vég. 7: 248. 1839. *Anemonidium* (Spach) Holub, Folia Geobot. Phytotax. (Praha) 9: 272. 1974. **TYPE**: **Anemonastrum dichotomum** (L.) Mosyakin, **comb. nov.** *Anemone dichotoma* L., Sp. Pl. 1: 540. 1753. *Anemonidium dichotomum* (L.) Holub, Folia Geobot. Phytotax. (Praha) 9: 272. 1974.

Anemone dichotoma was the only species originally included in this section by Spach (1839) and thus it is the type of the section.

Two North American species of *Anemonastrum* sect. *Anemonidium* can be placed in two subsections. The new combinations for these subsections and species are validated below.

Anemonastrum Holub [sect. *Anemonidium*] subsect. **Anemonidium** (Spach) Mosyakin, **comb. nov.** *Anemone* sect. *Anemonidium* Spach, Hist. Nat. Vég. 7: 248. 1839.

Anemonastrum canadense (L.) Mosyakin, **comb. nov.** *Anemone canadensis* L., Syst. Nat., ed. 12, 3: 231. 1768. *Anemonidium canadense* (L.) Á. Löve & D. Löve, Taxon 31: 124. 1982.

Anemonastrum Holub [sect. *Anemonidium*] subsect. **Richardsonia** (Ulbr.) Mosyakin, **comb. nov.** *Anemone* ser. *Richardsoniae* Ulbr., Bot. Jahrb. Syst. 37(2–3): 199. 1905. *Anemonidium* (Spach) Holub subgen. *Richardsonia* (Ulbr.) Starod., Vetrenitsy: sist. evol. 119. 1991. *Anemone* L. sect. *Richardsonia* (Ulbr.) Luferov, Byull. Glavn. Bot. Sada (Moscow) 182: 49. 2001. *Anemone* L. subgen. *Richardsonia* (Ulbr.) Luferov, Byull. Glavn. Bot. Sada (Moscow) 182: 49. 2001.

Jurtsevia Á. Löve & D. Löve, Bot. Not. 128: 511. 1976 [volume of 1975, published 1976].

Anemonastrum richardsonii (Hook.) Mosyakin, **comb. nov.** *Anemone richardsonii* Hook. in Richardson, Botanical Appendix to Franklin, Narr. J. Polar Sea, ed. 2, 21 (separate fascicle) [alternative pagination: Franklin, Narr. J. Polar Sea, ed. 2, Appendix 7: 749]. 1824; Hook., Fl. Bor.-Amer. 1(1): 6, tab. 4. 1829 (updated description). *Jurtsevia richardsonii* (Hook.) Á. Löve & D. Löve, Bot. Not. 128: 511. 1976 [volume of 1975, published 1976]. *Anemonidium richardsonii* (Hook.) Starod., Vetrenitsy: sist. evol. 119, 151. 1991.

It is widely accepted (Dutton & al. 1997; IPNI 2016 etc.) that *Anemone richardsonii* was described by Hooker in 1829 in the first issue of the first volume of his *Flora Boreali-Americana* (Hooker 1829). However, Hooker himself cited an earlier publication "Hook. in Frankl. 1st Journ. ed. 2. App. p. 21" (Hooker 1829: 6). Indeed, *A. richardsonii* was first validly described in a rare updated *Botanical Appendix* to the second edition of the *Narrative of a journey to the shores of the Polar Sea* (Richardson 1824). Petrovskiy (1971) cited the protologue of *A. richardsonii* as "Hook. in Franklin, Narr. J. Polar Sea, ed. 2, App. VII (1824) 749", but I was able to find only a separately paginated separate fascicle of the updated *Botanical Appendix*, which is available from the Biodiversity Heritage Library (see Literature Cited).

Anemonastrum Holub sect. **Anemonastrum**

This group is represented in North America by several taxa of the *Anemonastrum narcissiflorum* aggregate, which were treated in recent North American literature mainly as subspecies or varieties, or as separate species in many publications by Eurasian authors. Three varieties of *Anemone narcissiflora* were recognized in the *Flora of North America North of Mexico* (Dutton & al. 1997). In my opinion, these taxa are better treated as separate species, which are widely accepted in Eurasian literature (Juzepczuk 1931; Petrovskiy 1971; Starodubtsev 1991, 1995; Tzvelev, 2001, 2012; Malyshev 2005, 2012 etc.) and in the current online version of the *Annotated Checklist of the Panarctic Flora* (Elven 2016). Their nomenclature is updated and summarized below. Those preferring a wide concept of *Anemonastrum narcissiflorum* and the subspecies status of these taxa can use the names subsp. *sibiricum*, subsp. *villosissimum*, and subsp. *zephyrum* (as included in synonymy below); however, their species status is accepted here.

Anemonastrum sibiricum (L.) Holub, Folia Geobot. Phytotax. (Praha) 8: 165. 1973. *Anemone sibirica* L., Sp. Pl. 1: 541. 1753. *Anemone narcissiflora* L. subsp. *sibirica* (L.) Hultén, Acta Univ. Lund. n.s. (2. Afd.) 40: 734 [Fl. Alaska & Yukon 4: 734]. 1944. *Anemone narcissiflora* L. var. *sibirica* (L.) Tamura, Acta Phytotax. Geobot. 17: 115. 1958. *Anemonastrum narcissiflorum* (L.) Holub subsp. *sibiricum* (L.) Á. Löve & D. Löve, Bot. Not. 128: 511. 1976 [volume of 1975, published 1976].

Two additional subspecies of *Anemone narcissiflora* were described from North America by Hultén: subsp. *alaskana* Hultén (Acta Univ. Lund. n.s. (2. Afd.) 40: 733 [Fl. Alaska & Yukon 4: 733]. 1944) and subsp. *interior* Hultén (Acta Univ. Lund. n.s. (2. Afd.) 40: 734 [Fl. Alaska & Yukon 4: 734]. 1944). These taxa are evidently closely related to *Anemonastrum sibiricum* but their taxonomic status remains unresolved and they are in need of further study.

Anemonastrum villosissimum (DC.) Holub, Folia Geobot. Phytotax. (Praha) 11: 80. 1976. *Anemone narcissiflora* L. var. *villosissima* DC., Prodr. 1: 22. 1824. *Anemone villosissima* (DC.) Juz., Fl. URSS 7: 275. 1937. *Anemone narcissiflora* L. subsp. *villosissima* (DC.) Hultén, Acta Univ. Lund. n.s. (2. Afd.) 40: 732 [Fl. Alaska & Yukon, 4: 732]. 1944. *Anemonastrum narcissiflorum* (L.) Holub subsp. *villosissimum* (DC.) Á. Löve & D. Löve, Bot. Not. 128: 511. 1976 [volume of 1975, published 1976].

Anemonastrum zephyrum (A. Nelson) Holub, Folia Geobot. Phytotax. (Praha) 8: 165. 1973. *Anemone zephyra* A. Nelson, Bot. Gaz. 42: 51. 1906. *Anemone narcissiflora* L. subsp. *zephyra* (A. Nelson) Á. Löve, D. Löve & B.M. Kapoor, Arctic Alpine Res. 3: 149. 1971. *Anemonastrum narcissiflorum* (L.) Holub subsp. *zephyrum* (A. Nelson) W.A. Weber, Phytologia 41: 486. 1979. *Anemone narcissiflora* L. var. *zephyra* (A. Nelson) B.E. Dutton & Keener, Phytologia 77: 85. 1995 [volume of 1994, published 1995].

NORTH AMERICAN TAXA OF *PULSATILLA*: A NOMENCLATURAL UPDATE

Pulsatilla is represented in North America by two native species, the well-outlined *P. occidentalis* (S. Watson) Freyn (*Anemone occidentalis* S. Watson) and a more problematic taxon of the *P. patens* (L.) Mill. group. Some other taxa of *Pulsatilla* native to Eurasia may be expected in North America as occasional and local garden escapes. Native North American plants of the *Pulsatilla patens* aggregate were recognized by Dutton & al. (1997) as *Anemone patens* var. *multifida* Pritzel, which was described from Siberia (Pritzel 1841). The North American taxon has a very complicated synonymy and it is definitely not identical with the typical European–Western Asian *P. patens* sensu stricto (subsp. *patens*). Its correct name as a species of *Pulsatilla* is *P. nuttalliana* (DC.) Bercht. & J. Presl, which in a wide sense is also applicable to Siberian and northeastern Asian plants also treated as *P. nuttalliana* subsp. *multifida* (Pritz.) Aichele & Schwegler (1957; see also Petrovskiy 1971; Starodubtsev 1995; Kricsfalusy 2015; Elven 2016). Alternatively, if a very wide circumscription of *P. patens* is preferred and North American and Asian plants of the group are treated as belonging to the same taxon, the name *Pulsatilla patens* subsp. *multifida* (Pritz.) Zämelis can be applied (see Wang & Bartholomew 2001). An updated nomenclatural citation of *P. nuttalliana* and its synonyms and misapplied names is provided below; necessary nomenclatural explanations are also provided.

Pulsatilla nuttalliana (DC.) Bercht. & J. Presl, Přir. Rostlin, 1 (fasc. Ranunculaceae): 22. 1823. *Anemone nuttalliana* DC., Syst. Nat. 1: 193. 1817. *Anemone patens* L. var. *nuttalliana* (DC.) A. Gray, Manual Bot. N. United States, ed. 5: 36. 1867. *Pulsatilla patens* (L.) Mill. subsp. *nuttalliana* (DC.) Grey-Wilson, Pasque-Flowers. The Genus *Pulsatilla*, 163. 2014, nom. inval. (Art. 41.5 of ICN: McNeill & al. 2012; no direct reference to the place of publication: see IPNI 2016).

Heterotypic synonyms of *Pulsatilla nuttalliana*

Anemone patens L. var. *multifida* Pritz., Linnaea 15: 581. 1841. *Pulsatilla patens* (L.) Mill. subsp. *multifida* (Pritz.) Zämelis, Acta Horti Bot. Univ. Latv. 1: 98. 1926. *Pulsatilla multifida* (Pritz.) Juz., Fl. URSS 7: 296. 1937. *Anemone patens* L. subsp. *multifida* (Pritz.) Hultén, Acta Univ. Lund. n.s. (2. Afd.): 40: 738 [Fl. Alaska & Yukon 4: 738]. 1944. *Pulsatilla nuttalliana* (DC.) Bercht. & J. Presl subsp. *multifida* (Pritz.) Aichele & Schwegler, Feddes Repert. 60: 81. 1957. *Pulsatilla patens* (L.) Mill. var. *multifida* (Pritz.) S.H. Li & Y.H. Huang, Fl. Pl. Herb. Chin. Bor.-Or. 3: 163. 1975. *Pulsatilla patens* (L.) Mill. var. *multifida* (Pritz.) Kitag., Neolin. Fl. Manshur.: 305. 1979, comb. superfl.

Pulsatilla patens (L.) Mill. subsp. *asiatica* Krylov & Serg., Fl. Sibir. Occid. [Fl. Zapadnoi Sibiri] 5: 1165. 1931 (see the description in: Krylov 1931).

Pulsatilla ludoviciana A. Heller, Cat. N. Amer. Pl., ed. 2, 4. 1900, nom. illeg. (intended new combination based on illegitimate *Anemone ludoviciana* Nutt., but in fact a new name; type of *Clematis hirsutissima* Pursh excluded but *Anemone nuttalliana* DC. cited in synonymy).

Misapplied names for *Pulsatilla nuttalliana*

Pulsatilla hirsutissima (Pursh) Britton, Ann. New York Acad. Sci. 6: 217. 1891, p.p., quoad pl. (excluding the type of the basionym *Clematis hirsutissima* Pursh). *Pulsatilla patens* (L.) Mill. subsp. *hirsutissima* (Pursh) Zämelis, Acta Horti Bot. Univ. Latv. 1: 98. 1926, p.p., quoad pl. *Anemone hirsutissima* (Pursh) MacMill., Metasp. Minnesota Valley: 239. 1892, p.p., quoad pl. *Anemone hirsutissima* (Pursh) Makino, Bot. Mag. (Tokyo) 18 (No. 208): 69. 1904, comb. superfl., p.p., quoad pl.

Anemone ludoviciana Nutt., Gen. N. Amer. Pl. 2: 20. 1818, nom. illeg. (replacement name for *Clematis hirsutissima* Pursh).

Anemone wolfgangiana Besser in Rchb., Iconogr. Bot. Pl. Crit. 4: 41, tab. 351. 1826. *Pulsatilla wolfgangiana* (Besser) Rupr., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 12: 218. 1854. *Pulsatilla patens* (L.) Mill. var. *wolfgangiana* (Besser) Trautv. & C.A. Mey. in Middend., Reise Sibir. 1 (T. 2, Abt. 2: Fl. Ochot. Phaenog.): 7. 1856.

The authorship of the combination *Pulsatilla nuttalliana* has been often attributed to Sprengel (in Syst. Veg. ed. 16, 2: 663. 1825). However, Berchtold and J.S. Presl (1823) made this combination two years earlier. Their work *O Přirozenosti Rostlin aneb Rostlinář* was published in fascicles and later collected into three volumes. The first volume has a complicated pagination: it is not paged continuously but has 13 different groups of pages (Hunt Institute for Botanical Documentation 2016). *Pulsatilla* is treated in the fascicle *Rostliny Pryskýřnjkowité* (Ranunculaceae).

Dutton & al. (1997) commented that the "names *Pulsatilla hirsutissima* (Pursh) Britton and *P. ludoviciana* (Nuttall) A.Heller are illegitimate." It is certainly true for *Anemone ludoviciana* Nutt. because this name was proposed by Nuttall (1818) as an illegitimate new replacement name for *Clematis hirsutissima*, a species of a true *Clematis*, but the type of the replaced name has not been explicitly excluded (Art. 52.1 and 52.2 of ICN: McNeill & al. 2012). However, Heller (1900), when listing synonyms of his *Pulsatilla ludoviciana*, cited "*Pulsatilla hirsutissima* Britton, Ann. N.Y. Acad. Sci. 6: 217 1891; not *Clematis hirsutissima* Pursh". It means that he explicitly excluded the type of *C. hirsutissima* (which is also the type of the illegitimate name *Anemone ludoviciana*) and thus coined a new replacement name (not a new combination), but at the same time he cited as a synonym the name *Anemone nuttalliana* DC., thus anyway making his proposed new name illegitimate. In the *Annotated Checklist of the Panarctic Flora (PAF). Vascular Plants* (Elven 2016) the name *P. hirsutissima* is also considered "illegitimate because the given basionym is *Clematis hirsutissima* Pursh, Fl. Amer. Sept. 2: 385 (1813), a true *Clematis*." However, it is definitely **not** illegitimate: Britton in fact made a new combination (Art. 6.10 of ICN: McNeill & al. 2012) based on *C. hirsutissima* and thus his combination (as well as other combinations based on the same basionym) is just homotypic with its basionym (Art. 7.3 of ICN: McNeill & al. 2012) and thus is a legitimate nomenclatural synonym of *C. hirsutissima*, despite a long history of its (mis)application to a taxon of *Pulsatilla*.

Luferov (2004) listed the combination *Pulsatilla patens* subsp. *multifida* (Pritz.) Zämelis as an illegitimate name. However, I was unable to find any proof of its illegitimacy. When making his new combination, Zämelis (Zämels 1926) indeed listed in its synonymy the name *Pulsatilla patens*, but with the reference to Ledebour, which in modern terms should be understood as "*Pulsatilla patens* sensu Ledebour in *Flora Altaica*, not (L.) Mill. sensu stricto." Moreover, that name is a combination based on a legitimate basionym.

The use of the epithet "*wolfgangiana*" to North American and East Asian taxa of *Pulsatilla* is an evident misapplication. *Anemone wolfgangiana* was first validly described by Besser (1826) in the fourth volume of Reichenbach's *Iconographia Botanica seu Plantae Criticae* (**not** in Reichenbach's *Iconographia Botanica Exotica*, as erroneously stated in IPNI 2016, and **not** by "Besser ex W.D.J. Koch" in the fourth volume of the third edition of J.C. Röhlings's *Deutschlands Flora* revised by W.D.J. Koch, as occasionally mentioned in some other sources). The syntypes (LE, KW, and probably in some other herbaria) are from Lithuania, near Vilnius (Besser's collections made "in Lithuania prope Vilnas", "bei Vilna in Litthauen": Besser 1826: 41). This taxon, which is often treated as a species of hybrid origin, is probably conspecific with *P. teklae* Zämelis [*P. patens* subsp. *teklae* (Zämelis) Zämelis]; it occurs in Central and Eastern Europe (Poland, Baltic states, Belarus, northern Ukraine, and northwestern European Russia) (Tzvelev 2001, 2012). The misapplication of names based on *A. wolfgangiana* for plants from northeastern Asia (and later from North America) was most probably initiated by Trautvetter and C.A. Meyer, who proposed the name "*Pulsatilla*

patens Mill. var. *Wolfgangiana* nob. — *Anemone Wolfgangiana* Bess. in litt." (Trautvetter & Meyer 1856: 7), which should be treated as a new combination made by indirect reference, and thus the name of this variety has the same type as *A. wolfgangiana* Besser. In IPNI (2016) this combination is cited with the incorrect authorship ("Trautv. & E.Mey.") and inaccurate citation of the place of publication ("Fl. Ochot. Phaenog. 1 abt 2: 7. 1856 [Jan 1856]; alt. title: in Middend., Reise Sibir. 1 (abt 2): 7. Jan 1856"). The second author of *Florula Ochotensis Phaenogama* was Carl Anton (Karl Andreëvich) von Meyer, **not** Ernst Heinrich Friedrich Meyer. This *Florula* … (which itself has no volumes or issues) was published in the **separately paginated** second issue or fascicle (Abtheilung) of the second part (Theil) of the first volume of Middendorff's *Reise in den äussersten Norden und Osten Sibiriens*, and the volume information should be cited accordingly.

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RANGE EXTENSIONS FOR *ERYTHRANTHE ARVENSIS* AND *E. HALLII* (PHRYMACEAE)

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ABSTRACT

Recent study at the Rocky Mountain Herbarium (RM) has brought to light distribution records for *Erythanthe arvensis* (first record for the state of Wyoming) and *E. hallii* (new county records for Colorado). Photos of specimens and a distribution map are included.

ERYTHRANTHE ARVENSIS (Greene) Nesom Figures 1, 2.

The new record for Wyoming is closely adjacent to Bear Lake Co., Idaho, from where the species has previously been reported (*Shultz 2753,* UT; see Nesom 2012).

Wyoming. Lincoln Co.: Green River Basin, S end of Slate Creek Ridge, ca. 11.5 mi air mi NNE of Kemmerer, wet meadow draw with sagebrush sides and shrub islands, 7100-7500 ft, 5 Jul 1995, *Cramer 7157* (RM).

ERYTHRANTHE HALLII (Greene) Nesom Figures 1, 3, 4.

New records are recorded for Archeluta Co. and Routt Co., Colorado. Previous maps for this Colorado endemic (Nesom 2012, 2013) have indicated its occurrence in Jackson Co., but I am unable to relocate documentation for that. A summary of known records is presented here; many additional collections from Boulder and Larimer counties are housed at RM (examined and annotated by me).

Colorado. **Archeluta Co.**: Piedra, 14 Jul 1899, *Baker 588* (RM-2 sheets). Boulder Co.: Boulder, stream, 5700 ft, 20 Jun 1906, *Daniels 25* (MO); W of Boulder, rocky mossy streamlet, ca. 5500-5600 ft, 14 Jun 1915, *Pennell 5827* (PH); along trail from Buckingham campground to Fourth of July Mine, wet meadows, 9500 ft, 13 Aug 1979, *Teare & Taylor 1339* (DAV); seepage over granite slabs at base of S-facing slope in *Pinus ponderosa* woodland along Boulder Creek, 5600 ft, 21 Jun 1979, *Taylor & Teare 7396A* (DAV); beside a spring near summit of Flagstaff Mt., just W of Boulder, 7000 ft, 18 May 1949, *Weber 4653* (TEX, UC); 8 mi W of Lyons, South St. Vrain Canyon, 6300 ft, 12 Jun 1922, *Wiegand & Upton 4257* (MO). Clear Creek Co.: Georgetown, damp places, 18 Jul 1892, *Patterson 294* (MO, PH- 2 sheets, UC). Fremont Co.: canyon of the Arkansas River near Canon City, moist gravel of stream bed, 5400 m, 28 Jun 1950, *Ripley & Barneby 10172* (PH). Grand Co.: Devil's Staircase, East Inlet, 3.5 mi E of Grand Lake, Shadow Mt. area, moss banks on cliff in temporary seep areas, ca. 9000 ft, 20 Jul 1961, *Douglas 61-315* (UT); North Inlet 1/4 mi below Cascade Fall, 3 mi NE of Grand Lake, shaded ledge, under overhanging, S-facing cliffs, 8800 ft, 7 Aug 1961, *Douglas 61-480,* voucher for $n = 16$ (UT); Little Yellowstone Canyon, 14.5 mi N of Grand Lake, Rocky Mtn Natl Park, gravel at streamside, 9560 ft, 10 Aug 1961, *Douglas 61-488* (UT); Sulphur Springs, 23 Jul 1906, *Osterhout 3321* (DS). Jefferson Co.: Morrison, moist soil, 1970 m, 3 Jun 1921, *Clokey 4287* (UC); Morrison, 27 Jul 1889, *Greene s.n.* (ND-Greene); about Golden City, in shady ravines, at lower altitudes only, 1871, *Hall & Harbour 398* (MO-the type, GH digital image); Morrison, 5 Jun 1881, *Smith s.n.* (PH). Larimer Co.: Estes Park, moist ground, 29 Jun 1912, *Churchill s.n.* (MO); ravine E of Horsetooth Mtn, 26 May 1894, *Osterhout 291* (RM); Horsetooth Mtn, along streamlet, base of rocks, ca. 5700-5800 ft, 17 Jun 1915, *Pennell 5851* (PH); W of Horsetooth Mtn, wet shady ravine, ca. 5800-6000 ft, 17 Jun 1915, *Pennell 5858* (PH); Loveland, 55 mi above dam in Big Thompson Canyon, in seep on rocky ledge, no date, *Vickery cult 7313* (UT). **Routt Co.**: Fish Creek Falls, moist crevices, 21 Jul 1903, *Goodding 1650* (RM). Saguache Co.: Sargents, moist soil along stream, woods, ca. 8700-9300 ft, 2 Aug 1915, *Pennell 6299* (PH, RM).

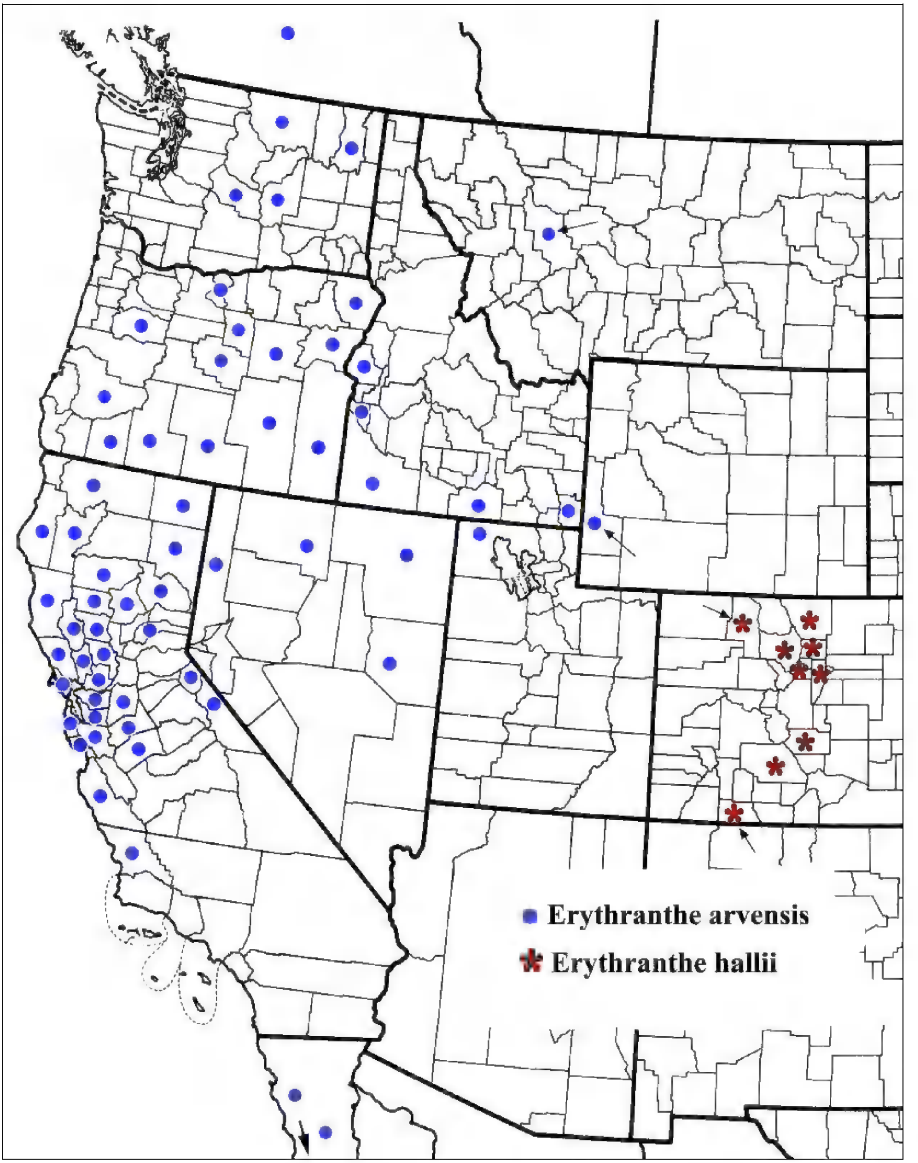

Figure 1. Distribution of *Erythranthe arvensis* and *E. hallii*. Arrows point to new records. The record for *E. arvensis* in Lewis & Clark Co., Montana (with arrow): vic. of Helena, [no date], *F.D. Kelsey s.n.* (PH) — as reported in Nesom (2013).

ROCKY MOUNTAIN HERBARIUM
Nº 642313
UNIVERSITY OF WYOMING, LARAMIE
Erythranthe arvensis (Greene) Nesom
Nesom 3416
Scrophulariaceae
WYOMING, U.S.A.
Mimulus guttatus DC.
var. guttatus
LINCOLN COUNTY
T23N R115W S27
Green River Basin: south end of Slate Creek Ridge, ca 11.5 air mi NNE of Kemmerer. South1/2 S27.
Wet meadow draw with sagebrush sides and shrub islands.
5 Jul 1995
Elev. 7,100-7,500 ft.
Tom Cramer # 7157
ROCKY MOUNTAIN HERBARIUM (RM), University of Wyoming

Figure 2. *Erythranthe arvensis* from Lincoln Co., Wyoming (*Cramer 7157*, RM), in typical morphology for the species. Inset shows enlargement of inflorescence with characteristic cleistogamous corolla.

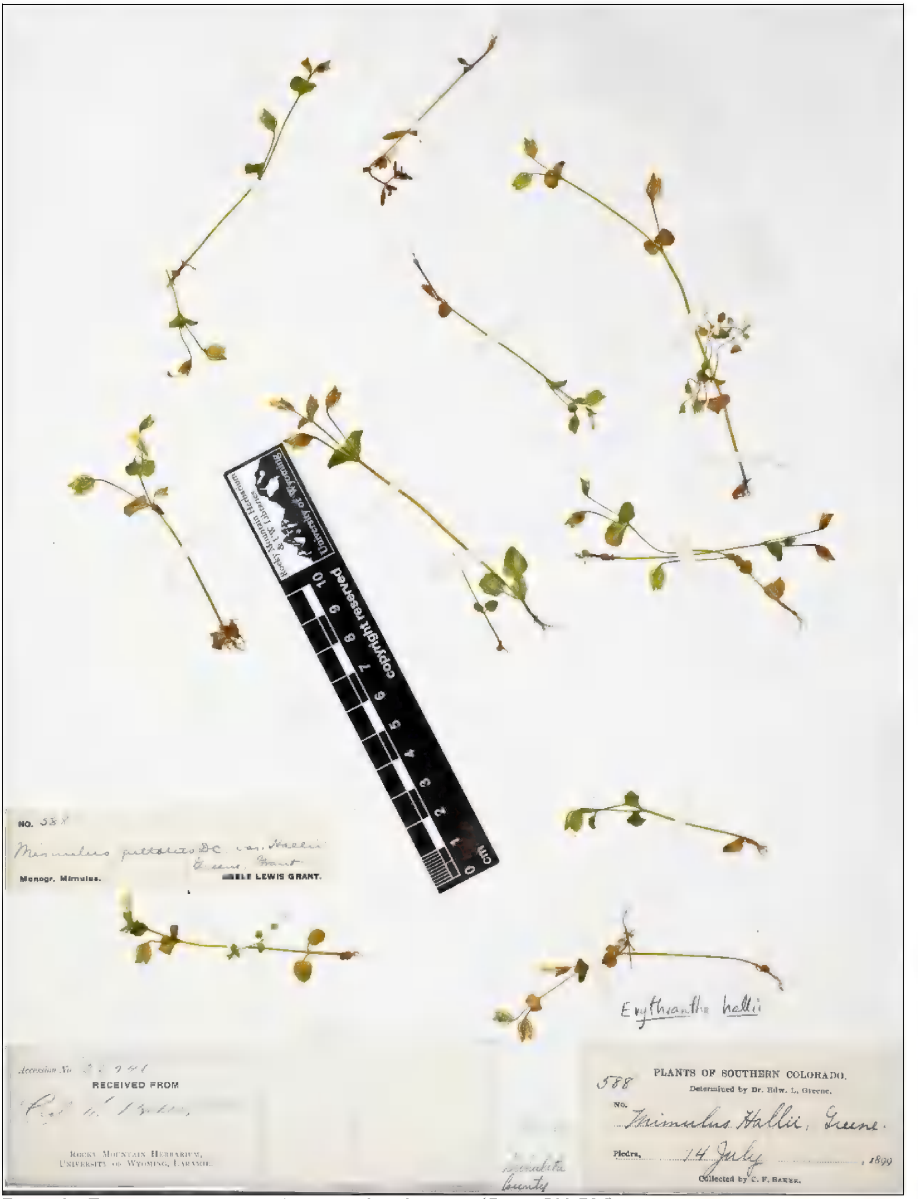

Figure 3. *Erythranthe hallii* from Archeluta Co., Colorado (*Baker 588*, RM).

Figure 4. Representative collection of *Erythranthe hallii*, Larimer Co., Colorado (*Osterhout 291*, RM). Note the characteristic cleistogamous corollas (see inset).

ACKNOWLEDGEMENTS

Many thanks to Ernie Nelson and Ron Hartman at RM (November 2016) for making the collections there, including many hundreds of unmounted ones, available for study and to RM volunteer Dave Mullens for providing the photos.

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TAXONOMIC NOTES ON UTAH *ERIGERON* (ASTERACEAE)

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ABSTRACT

Erigeron sionis Cronq. and *E. proselyticus* Nesom are distinct species, separate in mophology, ecology, and geography. *Erigeron religiosus*, previously regarded as a Utah endemic, has been collected in Mohave Co., Arizona, immediately adjacent to localities for the species in Kane Co., Utah. *Erigeron vagus* var. *madsenii* Welsh & Atwood is distinct from the rest of the species only in its separate geography, but population systems of *E. vagus* all are widely disjunct from one another and formal taxonomic status is not warranted for the central Utah populations. *Erigeron ursinus* var. *meyerae* Welsh is distinguished by branching stems; this apparently is a populational tendency in, Garfield, Iron, Kane, and Washington counties, Utah, and Coconino Co., Arizona, and formal taxonomic status for such variants is not warranted. *Erigeron katiae* Welsh, which is closely related to *E. pumilus*, appears to be a real entity and is recorded here as occurring in Rich and Wasatch counties, Utah, and Oneida Co., Idaho.

Recent study at BRY and RM provided an opportunity to examine several interesting taxonomic situations in Utah *Erigeron*.

1. Erigeron sionis and Erigeron proselyticus

In a taxonomic evaluation of *Erigeron flagellaris* var. *trilobatus* Maguire ex Cronq. (Nesom 1976), I found it distinct from typical *E. flagellaris* and probably most closely related to *E. sionis* Cronq., also possibly related to *E. religiosus* Cronq. In view of its distinction, I treated var. *trilobatus* at specific rank as *E. proselyticus* Nesom. Welsh (1993), however, regarded *E proselyticus* and *E. sionis* as conspecific and combined them, treating each at varietal rank, noting only (p. 398) that "This combination is made necessary by recognition of the close affinity of the material from near Cedar Breaks, Iron County [= *E. proselyticus*], with that of Zion Canyon [= typical *E. sionis*]." He did not address evidence supporting specific rank for *E. proselyticus*. Welsh (2008, p. 215) noted that the northern populations (*E. proselyticus*) "are sometimes slightly more robust, but careful analysis of numerous specimens from both localities have not demonstrated consistent morphological differences ... ." In the *Erigeron* treatment for FNANM (Nesom 2006), I acceded to Welsh's point of view, but a review of collections of both entities at BRY supports their distinction as separate species, in contrast to Welsh's study of the same set of specimens. The most recent edition of the Utah Flora (Welsh et al. 2015) still treats them as conspecific but the Utah Rare Plant Guide (UNPS 2016) treats *E. proselyticus* at specific rank.

Erigeron proselyticus Nesom, Brittonia 28: 266. 1976 [nom. et stat. nov., not *E. trilobus* Sond. 1856 or *E. trilobus* (Decne.) Boiss. 1875]. *Erigeron flagellaris* var. *trilobatus* Maguire ex Cronq., Brittonia 6: 258. 1947. *Erigeron sionis* var. *trilobatus* (Maguire ex Cronq.) Welsh, Rhodora 95: 398. 1993. TYPE: **Utah**. Iron Co.: canyon to Cedar Breaks, 12 mi E of Cedar City, 5 Aug 1934, *B. Maguire 14947* (holotype: NY digital image!).

Erigeron sionis Cronq., Brittonia 6: 258. 1947. TYPE: **Utah**. Washington Co.: Zion Canyon, Zion National Park, 1-3 Aug 1925, *H.A. Pilsbry s.n.* (holotype: PH digital image!).

The two population systems are distinct in morphology, have different ecologies, and are allopatric (see Fig. 1 and the ecological contrast below, based on data from BRY specimens). Plants of both are perennials with short, thick, and woody stolons; stems and leaves are glabrous to very

sparsely strigose, and leaves are mostly pinnately lobed or parted; ligules are mostly less than 40 per head. They differ as follows (following the FNA treatment).

1. Basal leaves usually with linear-oblanceolate lobes, less commonly entire to dentate, blades and/or lobes 1–3(–4) mm wide; ray corollas usually drying white to pink or light lavender; $2n=36$ ..... **Erigeron sionis**

1. Basal leaves entire or dentate, rarely deeply lobed, blades (2–)3–5(–11) mm wide; ray corollas usually drying pink to dark blue; $2n=18$ ..... **Erigeron proselyticus**

ERIGERON SIONIS

Sandstone (Navajo Sandstone, sometimes near the junction with underlying, sandy Carmel Formation); wall bases, cracks, ledges, and small soil pockets; (4100–)4500–7000(–7500) ft elevation. Surrounding vegetation of ponderosa pine-Douglas fir, ponderosa pine-oak, maple-Douglas fir, maple-oak, pine-manzanita-cercocarpus, pinyon pine-juniper, and velvet ash.

ERIGERON PROSELYTICUS

Limestone (mostly Claron Formation); vertical cliff faces, colluvium below cliffs, limestone gravels, loamy soil from limestone; 7200–10,000 ft elevation. Surrounding vegetation of spruce-aspen, spruce-fir-pine-aspen, aspen, bristlecone pine, bristlecone pine-limber pine, and Douglas fir-ponderosa pine.

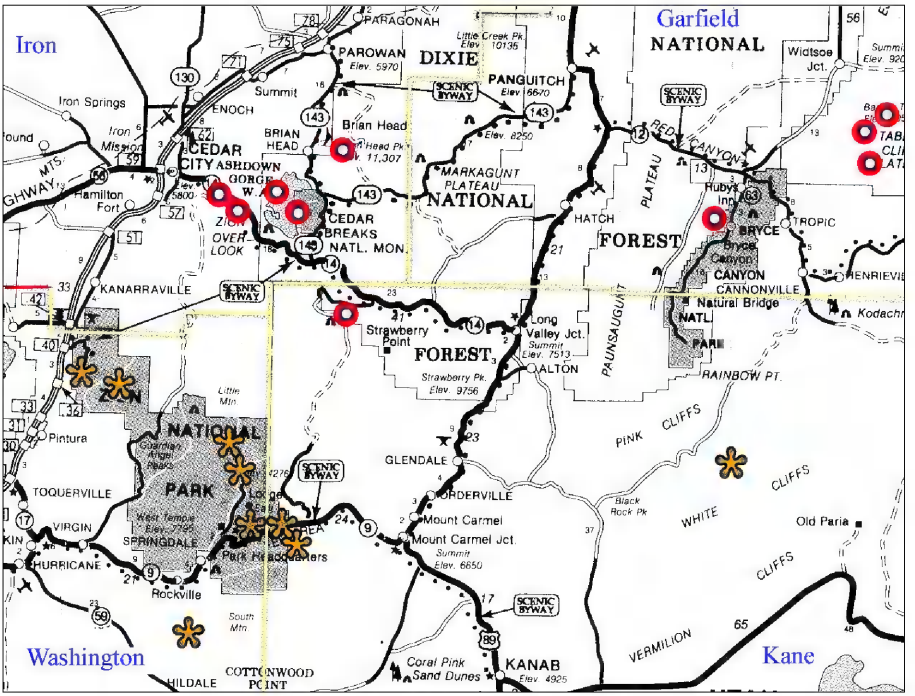

Figure 1. Distribution of *Erigeron sionis* (orange stars) and *E. proselyticus* (red circles). Symbols mostly represent more than one collection, based on specimens housed at BRY and studied July 2016. Base map is the "Map of State Roads" (1994 version) by the Utah Dept. of Transportation.

2. Erigeron religiosus in Arizona

Erigeron religiosus Cronq. is primarily an endemic of sandy sites in Washington and Kane counties, Utah, but it also has been found in closely adjacent localities in Arizona. Differences between *E. religiosus* and forms of *E. divergens* Torr. & Gray can be subtle and the identity of collections from San Juan Co. and Coconino Co. (those outside of the Washington/Kane/Mohave cluster) should be reevaluated.

Pertinent collections examined of *E. religiosus*. Arizona. Coconino Co.: Vermillion Cliffs National Monument, Paria Plateau, sandstone depressions, *Pinus edulis*, *Juniperus*, *Artemisia*, 5979 ft, 16 Sep 2003, *Atwood 29810* (ASC not seen, BRY!); Inscription House Canyon, 7 mi NW of Shonto, dry pond bottom, sandy soil, *Gutierrezia sarothrae*, *Salsola iberica*, 6400 ft, 29 May 1996, *Holiday 412* (ASC, not seen). Mohave Co.: Left Fork of Cottonwood Canyon, 36° 59.89' N, 112° 54.89' W, boxelder, dogwood, and serviceberry in sandy soil below Navajo sandstone, 5346 ft, 19 Jun 2003, *Atwood & Higgins 29603* (BRY!) and *Atwood & Higgins 29629* (BRY!). **Utah**. Kane Co. (immediately adjacent to the Mohave Co. site]: Cottonwood Canyon, Navajo sandstone substrate, ponderosa pine, oak, sagebrush community, 1650 m, 19 Jun 2003, *Higgins & Atwood 24746* (BRY!); Cottonwood Canyon at Washington/Kane Co. line, 1750 m, Navajo sandstone and blow sand, pinyon-juniper-oak-sagebrush, 14 Jun 2001, *Higgins 23230* (BRY) and *23249* (BRY!). San Juan Co.: Glen Canyon National Recreation Area, Lake Powell, near Mile Marker 57 (lake), San Juan Arm, first cove to the north, ca 0.5 mi up hike N of lake, small alcove and arch, 10 Oct 2002, *Heil et al. 21018* (SJNM!); Glen Canyon National Recreation Area, San Juan Arm, Fourth large alcove that leads to two tributaries ca 1/5 mi up canyon by boat, 10 Oct 2002, *Heil et al. 21053* (SJNM!).

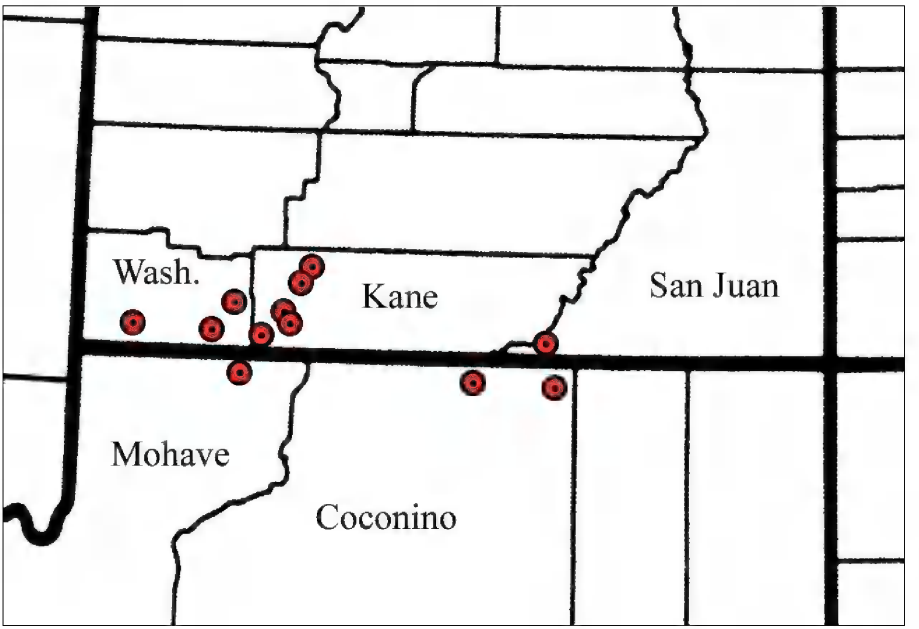

Figure 2. Distribution of *Erigeron religiosus*.

Asteraceae of Arizona
Flora of Grand Canyon National Park; on-GRCA 2001
SCF 0039
Erigeron ursinus D.C. Eat.
Coconino County, Arizona Trail, between No 03
(AzTrail Trailhead marking) towards Redberg Hill, N
W 112° 03' 59 6100 ft, 2470 m
3 August 2001
Wendy Hodgson 14715-B
with Liz Slayton, Dawn Goldman
herbarium of Desert Botanical Garden (DES)
HERBARIUM
DES
DATABASE
DES0005439

Figure 3. *Erigeron ursinus* with branching stems, Coconino Co., Arizona.

3. Erigeron ursinus var. meyerae

Welsh (2003, p. 189) formally recognized *Erigeron ursinus* D.C. Eat. var. *meyerae*, based on the branching stems of the variant, citing only two collections from Washington Co., Utah (cited below): they are "unique among our numerous collections in having branched stems, each of the curved-ascending branches bearing a solitary head. The remnant of the specimens are monocephalous." Study at BRY and RM, however, shows that plants of *E. ursinus* at the southwestern corner of the range of the species (Garfield, Iron, Kane, and Washington counties, Utah) are predominantly unbranched but collections from each of these counties sometimes have stems with 1-2 branches from midstem or above: Garfield Co.: *Ellison 94941* (RM); *Neese & White 3300A* (RM). Iron Co.: *Atwood 6978* (BRY), *Cronquist 11833* (RM), *Goodman & Hitchcock 1618* (RM), *Hitchcock et al. 4607* (RM), *Madsen 1723* (BRY), *Welsh 15505* (BRY). Kane Co.: *Atwood 7448* (BRY), *Madsen 1215* (BRY), *Madsen 1771* (BRY), *Madsen 2995* (BRY). Washington Co.: the type and paratype.

The branched-stem variant of *Erigeron ursinus* also occurs in adjacent northern Arizona (e.g., Coconino Co.: Grand Canyon National Park, Arizona Trail, between North Kaibab Trailhead travelling towards Lindberg Hill, spruce-fir mountain meadow, 8100 ft, 31 Aug 2001, *Hodgson 14715B* (DES digital image!, Fig. 3). Identities of other collections from Coconino Co. filed as *E. ursinus* (see SEINET) need to verified -- at least two are other species (*Little 4671*, RM! = *E. grandiflorus*; *Taylor & Pinkava 4453*, ASU digital image! = *E. divergens*).

Welsh (2003, p. 189) also noted that "The two specimens [of branched-stem *Erigeron ursinus*] available for study are apparently intermediate morphologically between *E. ursinus* and *E. nauseosus*, both of which occur in the general vicinity." In my examination of the type, paratype, and others of the branched-stem plants, I do not see morphological intermediacy or other evidence for the genetic involvement of *E. nauseosus*. Welsh did not provide details of the basis for his obervation.

In sum, I find no difference between typical *Erigeron ursinus* and var. *meyerae* except the branched stems. The variant is distinctive in morphology and geographically localized, but the branching appears to be only a populational tendency (pending field study) and formal recognition of the branched-stem plants seems unwarranted.

Erigeron ursinus var. *meyerae* Welsh, Utah Flora (ed. 3, rev.), 189. 2003. **TYPE: Utah**. Washington Co.: Lava Point Lookout, Zion National Park, Quaternary basalt, mesic to dry mesic mountain woodland, associated dominants — *Quercus gambelii*, *Artemisia tridentata*, *Sitanion hystrix*, *Abies concolor*, 7900 ft, 23 Aug 1970, *S.E. Meyer 1453* (holotype: BRY!).

Paratype: Utah. Washington Co.: Kolob Reservoir, 8100 ft, 17 Jul 1970, *Moor Z845* (BRY!).

4. Erigeron vagus var. madsenii

The original description of *Erigeron vagus* var. *madsenii* Welsh & Atwood provided a contrast to typical (presumably) *E. vagus* Payson: "Similis var. *vagus* in aspectum, sed foliis angustioribus viridis vel cinerascentibus bracteis involucrum viridis vel roseis vel purpureis differt." Var. *madsenii* is distinct from the rest of the species in its geography, but there appear to be 6 or 7 population systems of *E. vagus*, each of which is disjunct from the others (Fig. 4) and consistent morphological differences that would distinguish any of them are not apparent to me. In Utah, *E. vagus* is known from numerous sites (Garfield, Iron, Kane counties) on Claron limestone outcrops of the Paunsaugunt and Markagunt plateaus. While the var. *madsenii* populations probably are genetically distinct as a unit (based on their geographic isolation), the same probably is true for other disjuncts within the species and formal taxonomic status seem unwarranted for any of them without study of the whole group.

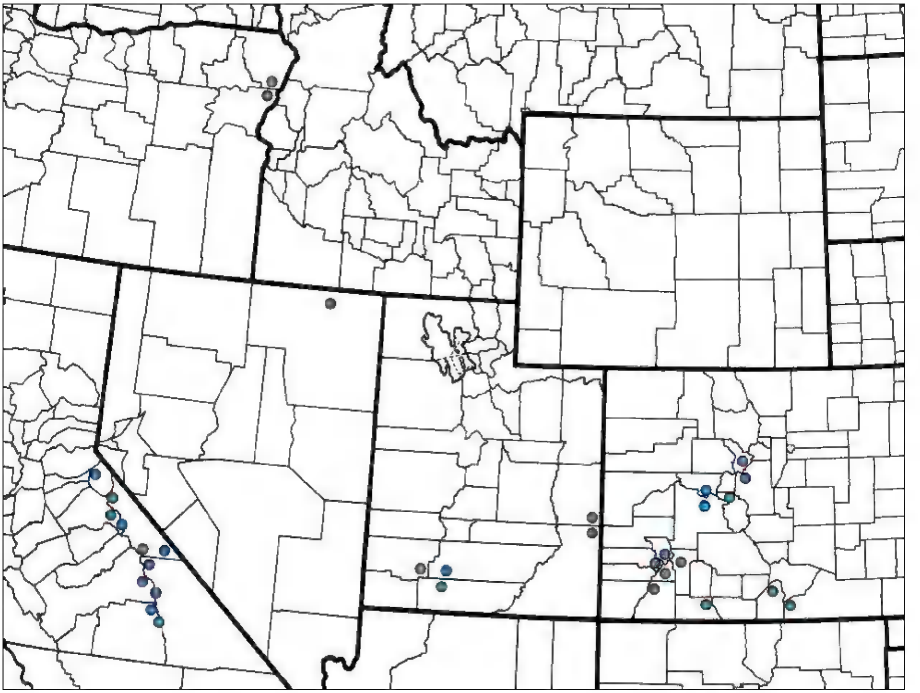

Figure 4. Distribution of *Erigeron vagus*, showing widely scattered-disjunct populations and population systems.

Erigeron vagus var. *madsenii* Welsh & Atwood, Utah Flora (ed. 4), 217. 2008. **Type**: **Utah**. Garfield Co.: Powell Point, on and near the scenic overlook, Table Cliff Plateau, Escalante RD/Dixie National Forest, white Claron limestone talus, 3105 meters, 8 Jul 2000, *M. Madsen 1025* (holotype: BRY!; isotype: NY digital image!).

5. Erigeron katiae

The plants described as *Erigeron katiae* Welsh & Atwood have antrorsely appressed stem vestiture, linear to linear-oblanceolate leaves, 31–40 ray flowers with white, reflexing laminae, and achenes 1.4–1.8 mm long with sparsely strigose faces and 9–10 pappus bristles. The diagnosis and protologue (Atwood & Welsh 2007) compared it to *E. nematophyllus* Rydb., which has strigose stems and linear leaves but ray flowers with coiling laminae and longer achenes (2.2–2.9 mm) with villous-hirsute faces and margins and 15–25 pappus bristles. The short achenes with few pappus bristles and especially the reflexing white rays indicate that *E. katiae* is more closely related to *E. pumilus* Nutt. and is a member of *Erigeron* sect. *Stenactis* Torr. & Gray (Nesom 2008, pp. 28-29).

Erigeron katiae is tentatively accepted here as a distinctive species of north-central Utah and adjacent Idaho (Fig. 5), but it seems unusually rare, inviting further study of its evolutionary status. Its distribution relative to *E. pumilus* and *E. concinnus* is shown in Figure 5. *Erigeron katiae* differs from *E. pumilus* var. *intermedius* in its strigose stems, narrower leaves, disc flowers without indurate-inflated throats (vs. indurate and inflated), fewer ray flowers (31-40 vs. 50-100), and fewer pappus bristles (9-10 vs. 12-20).

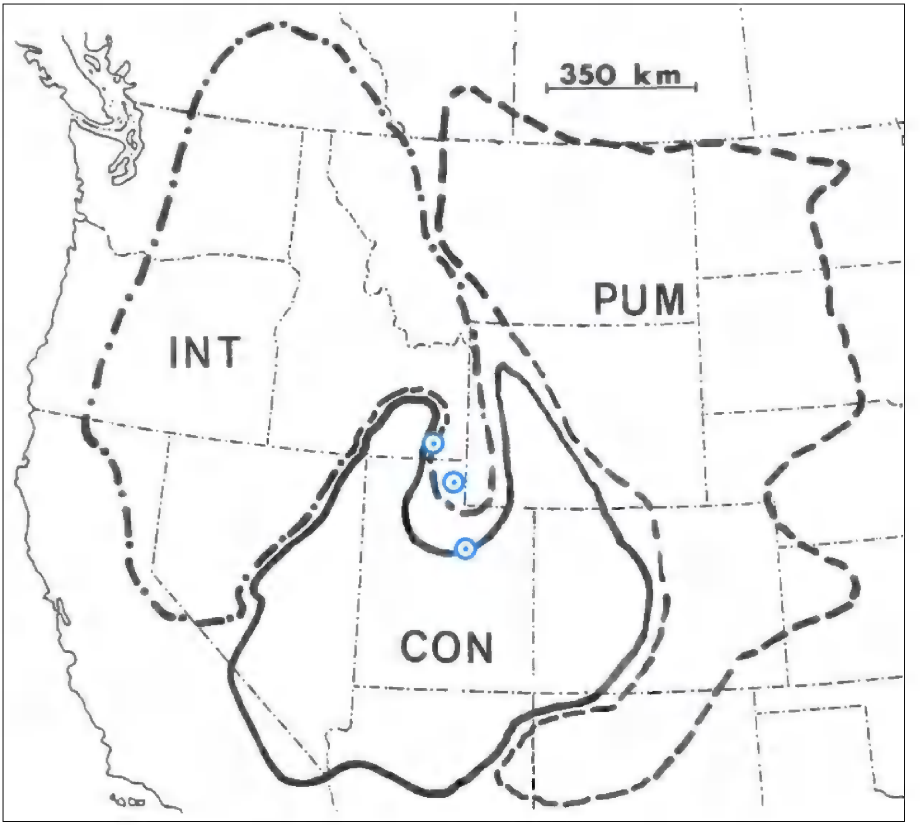

Figure 5. Distribution of *Erigeron katiae* (blue symbols) and close relatives *E. concinnus* (CON) and the two varieties of *E. pumilus* (var. *pumilus* PUM and var. *intermedius* INT). Map modified from Nesom (1983).

Erigeron katiae Welsh & Atwood, Rhodora 109: 411–413. 2007. **TYPE**: **Utah**. Rich Co.: Deseret Land and Livestock, Negro Dan Hollow, ca. 7 air mi SE of Deseret Home Ranch, rocky, SW-facing hillside, *Astragalus jejunus*, forb community [noted as "sagebrush community" elsewhere in the discussion], 6714 ft, 5 Jul 2005, *K. Moon et al. 868* (holotype: BRY!; isotypes: BRY-3 sheets!).

Additional collections examined. Idaho. Oneida Co.: North Cerlew Valley, Idaho State Hwy 38, 2 mi N of jct with Idaho State Hwy 37, 16.5 airline mi W of Malad City, among sagebrush and crested wheatgrass, 5000 ft, 6 Jul 1971, *Holmgren 5286* (BRY); no specific locality data, 5000 ft, 30 May 1972, *Moran s.n.* (BRY). **Utah**. Rich Co.: West Stacey pasture on Deseret Land and Livestock Ranch, 41 20'31" N, 111 06' 10" W, sagebrush, 2004, *Woodland s.n.* (UTC digital image!). Wasatch Co.: Uintah Natl Forest, Strawberry Valley, Windy Ridge, windswept ridge with *Artemisia frigida*, 7940 ft, 14 Jul 2011, *Goodrich 28243* (BRY).

Figure 6. *Erigeron katiae*, Rich Co., Utah. Isotype BYU 509191.

Figure 6. *Erigeron katiae*, Rich Co., Utah. From *Woodland s.n.* (UTC). Stems and leaves loosely strigose.

ACKNOWLEDGEMENTS

I'm grateful to Robert Johnson (BRY) and Ernie Nelson (RM) for their hospitality and help.

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Kraft, J. 2016. *Bidens alba* (Asteraceae) new to the Tennessee flora. Phytoneuron 2016-82: 1–2. Published 12 December 2016. ISSN 2153 733X

BIDENS ALBA (ASTERACEAE) NEW TO THE TENNESSEE FLORA

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ABSTRACT

Bidens alba var. *radiata* is reported for the first time as naturalized in Tennessee, where found as a weed adjacent to a parking lot in the city of Clarksville. The species is known to be naturalized in southern states around Tennessee, including Kentucky, Alabama, South Carolina, and Georgia.

Based on the following specimen, *Bidens alba* (L.) DC. is documented here as naturalized in Tennessee. Montgomery Co.: city of Clarksville, off Interstate Hwy 24 near the intersection of Wilma Rudolph Blvd. and South Hampton Place, adjacent to a parking lot and weedy field near an apartment complex (36° 35'28.964" N, 87° 17'58.156" W), 9 Nov 2016, *Kraft 001* (APSC).

Bidens alba is native to the American tropics, Asia, and Africa and has since spread and naturalized around the world. In the USA it is a weedy invasive in Hawaii, Alabama, Kentucky, Georgia, South Carolina, and other states throughout the South. The nearest population of *B. alba* is from Madison Co., Kentucky (Kartesz 2014).

Bidens alba is characterized as having broadly spatulate involucral bracts, heads with 5-8 white rays, ligules 2 times longer than broad, simple leaflets, 2-awned achenes, and a tetraploid chromosome number (Ballard 1986). Plants of the species in the southeastern USA are identified as *B. alba* var. *radiata* (Sch.-Bip.) Ballard ex Melchert (Weakley 2015).

Figure 1. *Bidens alba* in Montgomery Co., Tennessee. Photo by Josh Kraft, 9 Nov 2016.

ACKNOWLEDGEMENTS

The author is grateful to Mason Brock, Herbarium APSC, and Dr. L. Dwayne Estes, APSC Curator, for their help in identifying the specimen.

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COMPOSITAE OF CENTRAL AMERICA–VI. *PERYMENIUM HONDURENSE*, *PODACHAENIUM SALVADORENSE*, AND *VERBESINA MONTEVERDENSIS*, THREE NEW WOODY SPECIES OF HELIANTHEAE

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ABSTRACT

Yellow-rayed **Perymenium hondurense** Pruski, **sp. nov.** (Compositae: Heliantheae: Ecliptinae) from Honduras is described. By its arborescent habit and winged fruits it resembles *Perymenium grande* Hemsl., but differs by its pinnately-veined finely serrulate-denticulate leaves, pyriform outer phyllaries, and narrow-tipped inner phyllaries. A key to the ten Mesoamerican species of *Perymenium* is provided. White-rayed **Podachaenium salvadorense** Pruski, **sp. nov.** (Compositae: Heliantheae: Verbesininae) is validated, and *Podachaenium* Benth. is accepted now as containing six species. By woody habit and densely persistent-hirtellous obgraduate phyllaries, *Podachaenium salvadorense* is most similar to *Podachaenium chiapanum*, but differs by its cypselae with usually four(–five) slightly to moderately unequal elongate scales without intermediate small squamellae. A distribution map and a key distinguishing *Podachaenium salvadorense* from regional congeners are given. Alternate-leaved yellow-rayed **Verbesina monteverdensis** Pruski, **sp. nov.** (Compositae: Heliantheae: Verbesininae) is described. It is most distinctive in its obgraduate phyllaries and subsquarrose outer phyllaries, but differs from other similar regional species by pilosulose corolla tubes, glabrous to weakly pubescent herbage with straight trichomes, and by relatively small leaves, capitulescences, and capitula. As fruit characters help diagnose each genus here treated, SEM micrographs of cypselae of each new species are provided.

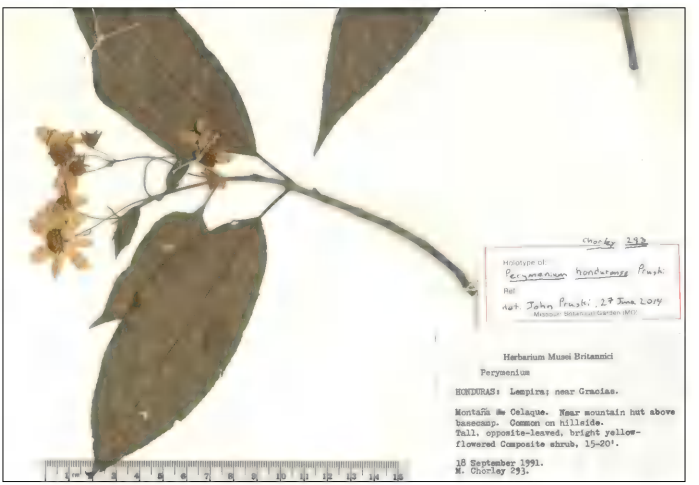
Study of recent collections of the Central American Heliantheae (Compositae) for Flora Mesoamericana has resulted in discovery of three new woody species of *Perymenium* Schrad., *Podachaenium* Benth., and *Verbesina* L. Plants from Honduras, based on their pistillate yellow-rays and caducous-pluriaristate pappus, are placed *Perymenium* (subtribe Ecliptinae sensu Panero 2007), where they are most distinctive by their pinnately veined leaves. The five collections with pinnately veined leaves known to me have been identified previously as one of four names: *Perymenium ghiesbreghtii* B.L. Rob. & Greenm., *P. grande* Hemsl., *P. nicaraguense* S.F. Blake, and *P. purpusii* Brandegee. This *Perymenium* with pinnately veined leaves is described here as *Perymenium hondurense* Pruski, a species typical of Ecliptinae by its disk corolla throats with fibers embedded in the nerves.

Also described here are species of *Podachaenium* and *Verbesina* of Verbesininae, a subtribe with a checkered past. Although Robinson (1981) recognized Ecliptinae as including *Verbesina* and Bremer (1994) recognized Verbesininae but treated *Eclipta* L. as incertae sedis, I follow Panero (2007), who recognized Ecliptinae and Verbesininae as distinct. A white-rayed Compositae from El Salvador is named as *Podachaenium salvadorense* Pruski, and *Podachaenium* (Compositae: Heliantheae: subtribe Verbesininae) is now accepted as containing six species. *Podachaenium salvadorense* is most similar to *P. chiapanum* B.L. Turner & Panero, but differs most strikingly by its disk cypselae with a nearly *Tetrachyron*-like pappus usually of four(–five) only slightly to moderately unequal long scales (the lateral two–three technically represent elongated squamellae and are more fimbriate than the two true radial scales) without intermediate reduced squamellae. Lastly, *Verbesina monteverdensis* Pruski, also of subtribe Verbesininae, is described. It is most distinctive by its obgraduate phyllaries and subsquarrose outer phyllaries. In the involucre character it resembles

Guatemalan endemic *V. eperetma* S.F. Blake, which differs by capitula twice the size of the Costa Rican species. *Verbesina monteverdensis* is compared to the other 15 alternate-leaved yellow-rayed Central American Verbesinas and involucral differences notwithstanding, the new species seems moderately similar to *V. oerstediana* Benth., but would key in D'Arcy (1975) to *V. lanata* B.L. Rob. & Greenm.

Perymenium was monographed by Robinson and Greenman (1899a) as containing 26 species, treated by Fay (1978) as containing 33 species in Mexico and Central America, and cited as having between about 36–50 total species by Strother (1999), Panero (2007), and Turner (2014). Most species of *Perymenium* are found in Mexico and Central America, and only a handful occur in the northern Andes. Among American genera of Ecliptinae, *Perymenium* by its caducous pluriaristate pappus perhaps is most similar to widespread *Melanthera* Rohr and northern Andean *Steiractinia* S.F. Blake, but it differs from *Melanthera* by yellow-flowered radiate (vs. typically white-flowered discoid) capitula and from *Steiractinia* by pistillate (vs. sterile) ray florets. Amazonian-centered *Tilesia* G. Mey. (syn.: *Wulffia* Neck. ex Cass.) is similar in gestalt to *Perymenium,* but differs from it by sterile ray florets in addition to its strange fleshy berry-like epappose fruits (Pruski 1996; Panero 2007).

Perymenium hondurense differs from each of the four aforementioned species of *Perymenium* (as well as from the entire core of this genus of 36–50 species) by its pinnately-veined finely serrulate-denticulate leaves. By the technical character of winged fruits the Honduran plant resembles the species of the *P. grande* group, the only species group present from El Salvador and Honduras south to Costa Rica. Although *P. nelsonii* was treated by Fay (1978) as a variety of *P. grande*, it differs quite noticeably from the nominant variety by its capitula about twice as large and by apically broadly rounded inner phyllaries that contrast strongly to the paleae. On the other hand, the other taxa of the group have much smaller capitula than does *P. grande*. Even though capitula size is used taxonomically as the most facile feature distinguishing the previously described species of the *P. grande* group and capitula size quite naturally may vary ecologically, the species of this group nevertheless seems distinct from each other, and by the trinerved leaves reasonably different from the newly described *P. hondurense*.


Chorley 293
Holotype of:
Perymenium hondurense Pruski
Ref:
Nat. John Pruski, 27 June 2014
Missouri Botanical Garden (MO)
Herbarium Musei Britannici
Perymenium
HONDURAS: Lempira; near Gracias.
Montaña de Celaque. Near mountain hut above basecamp. Common on hillside. Tall, opposite-leaved, bright yellow-flowered Composite shrub, 15-20'.
18 September 1991.
M. Chorley 293.
Figure 1. Holotype of *Perymenium hondurense.* (*Chorley 293*, MO).

Among wing-fruited species *Perymenium hondurense* appears to most closely resemble woody *P. grande* (Figs. 6–7), especially in size of capitula and by inner phyllaries that are more or less transition in shape and texture to the paleae. The new species from Honduras differs from *P. grande*, however, by consistently pyriform (vs. ovate to lanceolate-ovate) outer phyllaries and apically acuminate to attenuate (vs. obtuse and oblong) inner phyllaries. Although Fay (1978) in his monograph interpreted similar variation in phyllary features as found within *P. ghiesbreghtii* B.L. Rob. & Greenm., I do not find such extreme variation elsewhere in the genus. Thus, phyllary characters and leaf venation are used here to distinguish taxa. A key to the ten Mesoamerican species of *Perymenium*, each with a more or less graduated involucre, follows the description.

PERYMENIUM HONDURENSE Pruski, **sp. nov. TYPE**: **HONDURAS. Lempira.** Near Gracias, Montaña de Celaque, sin. elev., 18 Sep 1991, *M. Chorley 293* (holotype: MO; isotype: BM). Figs. 1–5.

Frutex vel arbor 2.5–8 m alta; caules subhexagoni distale hispidulosa vel substrigosa; folia opposita petiolata, lamina 7–14 × 1.5–5 cm anguste elliptica pinnatim venosa serrulata-denticulata subtus glandulosa et hirsuto-pilosa; capitulescentia 6–22 cm diam. corymbiforma vel corymbiformi-paniculata; pedunculi 10–40 mm longi; capitula radiata; involucrum 5–7 × 4–7 mm campanulatum; phyllaria circiter 3-seriata, externa pyriformia interna lanceolata; flosculi radiati 8 pistillati, corollis luteolis, limbo 10–14 × 3–6 mm obovato 13–15-nervio; flosculi disci 30–40, corollis 4.8–5.5 mm longis infundibuliformis luteolis; cypselae 3–4 mm longae alatae; aristae pappo 10–15, 0.6–3.2 mm longae.

Figure 2. Close-up from Figure 1 of capitula of holotype of *Perymenium hondurense* showing involucre with outer pyriform phyllaries about half as long as to 2/3 or more as long as the inner phyllaries (*Chorley 293*, MO).

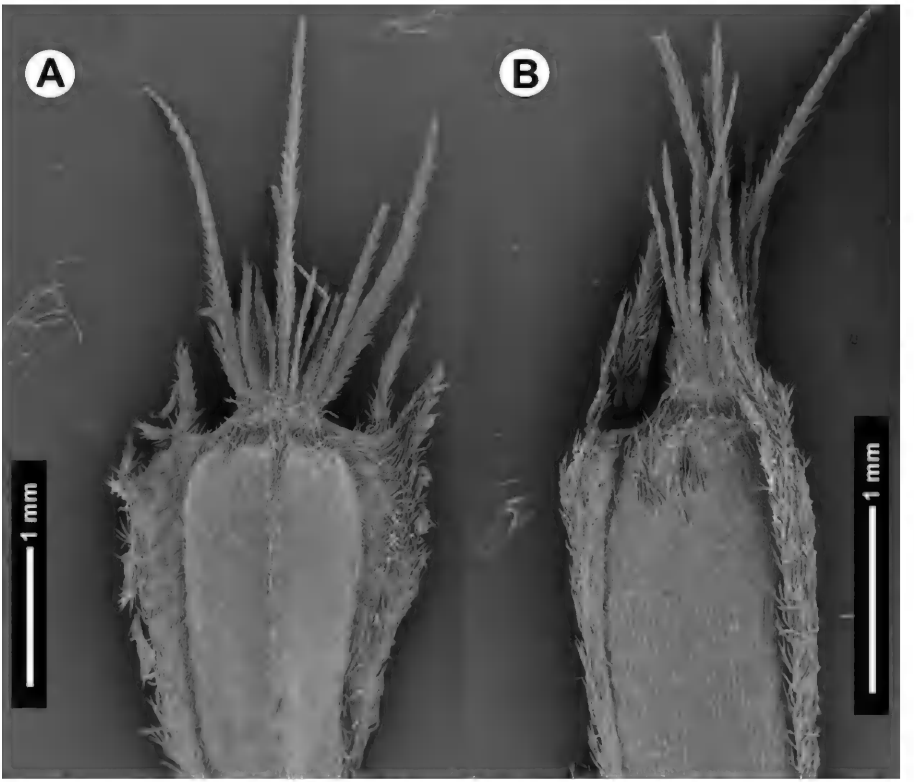


Figure 3. SEM micrographs of cypselae from holotype of *Perymenium hondurense* showing narrow marginal wings (from base to apex), rostra, and pluriaristate pappus of fragile awns. Each wing extends distally from the shoulders into a pappus-like appendage. The short central rostrum is topped by several short and a few elongate pappus awns. A. Abaxial (inner) face of slightly obcompressed triquetrous ray cypsela showing lateral margin wings. B. Biconvex disk cypsela (lateral face) showing radial margin wings (*Chorley 293*, MO).

Shrubs or trees 2.5–8 m tall; stems with branches ascending, straight, exalate, sulcate-costate and subhexagonal, hispidulous or substrigose with antrorse(–subappressed) trichomes; herbage never stipitate-glandular. **Leaves** opposite, petiolate; blade 7–14 × 1.5–5 cm, narrowly elliptic, broadest near mid-blade, stiff-chartaceous, venation more or less evenly and regularly pinnate, never clearly trinerved from above base, secondary veins 9–13 per side, equally spaced and equally thickened, ascending at about 45 ° from stems, sometimes a pair of mid-leaf slightly more forward directed and hinting at the trinerved condition that very nearly characterizes the genus, the occasionally slightly more arching pair of veins not thicker than the other secondaries, tertiary reticulations moderately well-defined, surfaces more or less concolorous, adaxial surface scabrous-hirtellous, abaxial surface glandular, also hirsute-pilose to densely so with antrorse trichomes, base cuneate to obtuse but never with a clearly defined basal acumen, margins finely and evenly serrulate-denticulate with about 30–40 teeth per side, teeth ca. 0.2 mm long, apex acuminate to attenuate; petiole 1–2 cm long, hispidulous or substrigose. **Capitulescence** terminal, 6–22 cm diam., somewhat openly corymbiform to corymbiform-paniculate, (7–)17–50+–capitulate; peduncles mostly 10–40 mm long, filiform, ebracteolate. **Capitula** radiate; involucre 5–7 × 4–7 mm, campanulate; phyllaries

ca. 3-seriate, unequal with 1–2 outer phyllaries about half as long as inner to nearly subequal with most outer phyllaries usually more than 2/3 as long as the inner, 2–3 mm diam., stiff, the pale indurate base appressed, the green-subherbaceous apex spreading; outer phyllaries pyriform, moderately to densely strigillose or strigose, apex acute to obtuse; inner phyllaries lanceolate, progressively less pubescent, more or less transitional in shape and texture to paleae, apex acuminate to attenuate; clinanthium paleate, convex; paleae 5–6 mm long, conduplicate, midrib hispidulous, herbaceous and carinate distally, apex acute to sometimes apiculate. **Ray florets** 8, pistillate; corolla golden-yellow, tube ca. 1.5 mm long, limb 10–14 × 3–6 mm, obovate, 13–15-nerved, abaxially minutely glandular and setulose, apex rounded, 2–3-denticulate. **Disk florets** 30–40, bisexual; corolla 4.8–5.5 mm long, funnelform, golden-yellow, tube 1.2–1.3 mm long, throat slightly longer than tube with thin fibers embedded in the nerves, lobes 0.6–1 mm long, hirtellous; anthers 2–2.5 mm long, black, appendage ca. 0.3 mm long, lanceolate, stramineous; style short-appendiculate, branches ca. 1.2 mm long, spreading, stigmatic surfaces 2-banded. **Cypselae** somewhat dimorphic, the rays triquetrous, the disks biconvex, 3–4 mm long (excluding wings), body black, smooth, eglandular, broadly rounded distally and short-rostrate, sparsely strigillose-setulose distally, narrowed apex ca. 0.3 mm tall, margins mostly thinly winged to near base, wings 0.2–0.5 mm diam., wings prolonged distally into pappus-like lateral appendages, base without elaiosomes, carpopodium not prominent; ray cypselae slightly obcompressed and triquetrous, winged on lateral margins, adaxial margins typically merely strigillose-setulose; disk cypselae somewhat radially compressed, biconvex, winged on radial margins, wings narrower than in rays; pappus pluriaristate, of 10–15 unequal caducous awns set in from margins, 0.6–3.2 mm long.

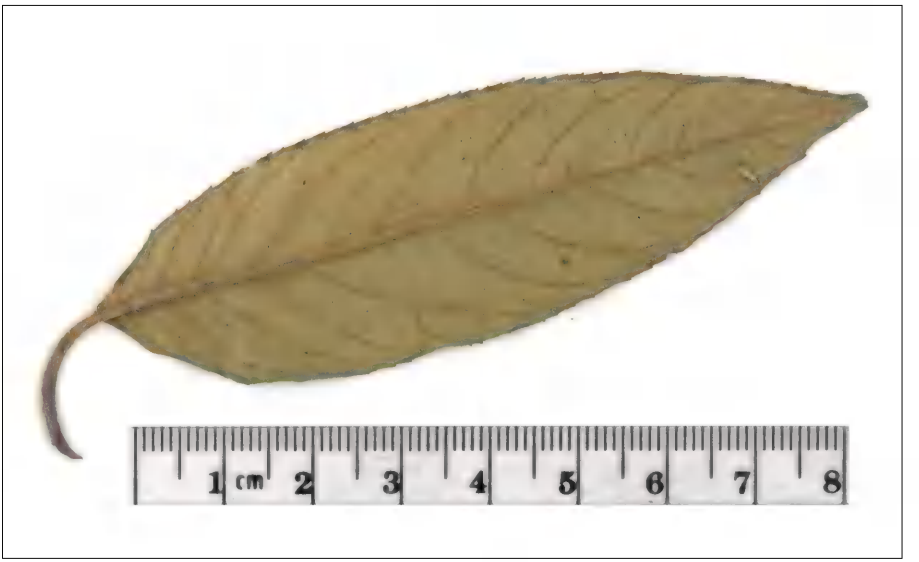


Figure 4. Abaxial view of leaf from a paratype of *Perymenium hondurense* showing pinnate blade venation with lateral veins more or less equally thick (*House 1040*, MO).

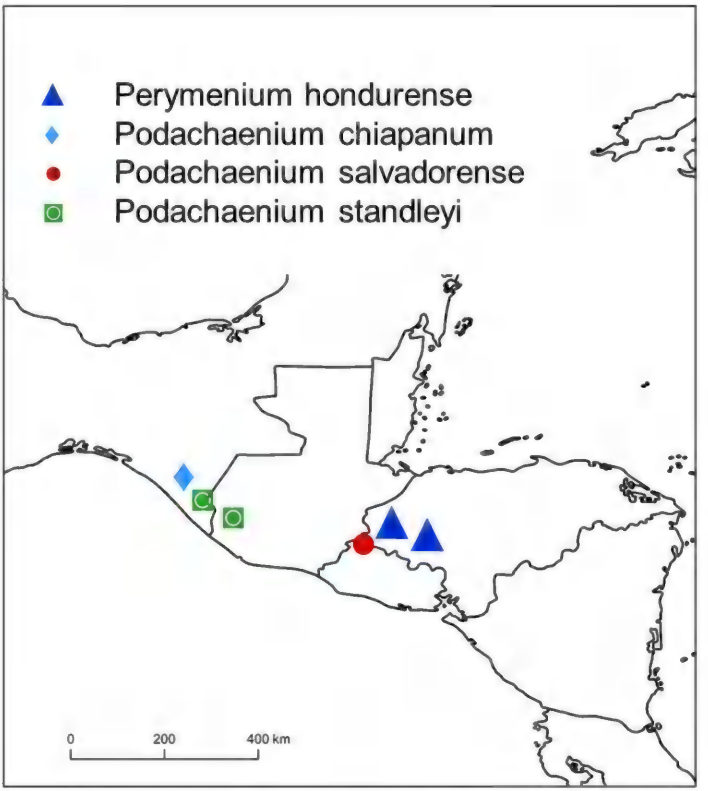


Figure 5. Distributions of *Perymenium hondurense*, *Podachaenium chiapanum*, *Podachaenium salvadorense*, and *Podachaenium standleyi*.

Paratypes. **HONDURAS. Intibucá.** Cerro San Cristobal, La Esperanza, 2000 m, 12 Sep 1981, *T. Mejía* 70 (MO); Cerro Pelanariz, 1.5 km al NE de La Esperanza, 2000 m, 13 Sep 1981, *Sosa 37* (MO). **Lempira.** Parque Nacional de Celaque, cerca del Campamento de Don Tómas, 2000 m, 10 Jul 1991, *Paul House 1040* (EAP, MO, TEFH); Al noreste del Campamento Naranjo, 11 km al suroeste de Gracias, Parque Nacional de Celaque, 2530 m, 7 Aug 1992, *D. Mejía 206* (EAP, HEH, MO, TEFH).

Etymology, distribution, and ecology. *Perymenium hondurense* is endemic to western Honduras (whence the epithet). It occurs in wet premontane forests, secondary forests, and cloud forests from about 2000–2530 meters elevation, and flowers from July until November.

Perymenium hondurense is reminiscent of Central America *Lundellianthus steyermarkii* (S.F. Blake) Strother, South American *Oyedaea wedelioides* (Klatt) S.F. Blake, South American *Steiractinia ocanensis* S.F. Blake, and South American *Wedelia penninervia* S.F. Blake in that each is a penninerved species belonging to genera of Heliantheae-Ecliptinae that are predominantly characterized by trinerved-leaved species. The penninerved vs. trinerved leaf venation character is much used in characterizing taxa in Heliantheae Alliance (sensu Panero 2007), and although perhaps sometimes environmentally influenced it generally seems to be useful and trustworthy taxonomically.

MISSOURI
BOTANICAL GARDEN
HERBARIUM
Nº 6119675
GUATEMALA
ASTERACEAE
Perymenium grande Hemsl. var. grande
det. John Pruski (MO), 2008
Dept. JALAPA: Along unpaved road in forest between Jalapa and MIRAMUNDO, ca. 6 km WSW of Jalapa. ELEV.: 1580 meters.
14°36'39"N 090°01'56"W
Near type locality of P. jalapanum S & S; frequent tree to about 4 m tall; phyllaries herbaceous, graduated, 2-3-seriate, to 6 mm long; rays pistillate; corollas yellow; cypselae obcompressed, black, narrowly 2-winged to base, very short-rostrate, rays triquetrous; pappus of 10-15 short awns.
16 November 2008
John Pruski, José Juan Vega, Sofia Ortiz & Jorge Jiménez 4550
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)
0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
MISSOURI BOTANICAL GARDEN

Figure 6. Representative specimen of *Perymenium grande* var. *grande* showing trinerved leaf blades broadest in proximal third (*Pruski et al. 4450*, MO).

At one point I had considered using the epithet "penninervium" for the new species, but given that the generic boundaries in Ecliptinae often waver and that *Wedelia* Jacq., the oldest generic name in the group, includes *W. penninervia*, it seems preferable to use an epithet less likely to be blocked amid possible generic restructuring. Among Heliantheae sensu lato I find only *Desmanthodium hondurense* Ant. Molina (tribe Millerieae) and *Tithonia hondurensis* La Duke (Heliantheae subtribe Helianthinae) using this adjectival geographic epithet, clearing the path for the use of "hondurense" in the moderately distantly related *Perymenium* of Heliantheae subtribe Ecliptinae.

Key to the Mesoamerican species of *Perymenium*

1. Cypselae often winged to the base or nearly so, wings typically prolonged distally into pappus-like appendages; leaf blade abaxial surfaces typically glandular.

2. Involucres 3.5–5 × 3–5 mm.

3. Perennial herbs to sprawling soft-wooded shrubs; leaf blades widest near the base, adaxial surface substrigillose to hispidulous, abaxial surface hirsute-pilose, trichomes antrorse to patent; phyllaries often moderately glandular, apices broadly obtuse to rounded; (Mexico, Guatemala) ..... **Perymenium gymnolomoides** (Less.) DC.

3. Erect shrubs or small trees; leaf blades widest near the middle, surfaces strigillose, trichomes appressed; phyllaries eglandular or sparsely glandular, apices usually acute to obtuse; (Mexico, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica) .....**Perymenium nicaraguense** S.F. Blake

2. Involucres 4.5–13 × 4–10 mm.

4. Leaf blades pinnately-veined, broadest near middle; outer phyllaries consistently pyriform; inner phyllaries lanceolate, apically acuminate to attenuate; (Honduras) ..... **Perymenium hondurense** Pruski

4. Leaf blades trinerved, broadest in proximal third; outer phyllaries ovate to lanceolate-ovate; inner phyllaries oblong, apically obtuse.

5. Inner phyllaries typically appressed, typically transitional to paleae, apices acute to obtuse; involucres 4.5–6 × 5–6.5 mm; (syns.: *P. grande* var. *strigillosum* B.L. Rob. & Greenm., *P. tuerckheimii* Klatt); (Mexico, Guatemala, Honduras, El Salvador) ..... **Perymenium grande** Hemsl. var. **grande**

5. Inner phyllaries spreading distally, contrasting with paleae, apices mostly rounded; involucres 7–13.5 × 6–10 mm; (syn.: *P. latisquamum* S.F. Blake); (Mexico, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica) ..... **Perymenium grande** var. **nelsonii** (B.L. Rob. & Greenm.) J.J. Fay

1. Cypselae exalate although sometimes sharp-edged, cypsela shoulders rounded and typically not prolonging into pappus-like appendages or very rarely with ray cypselae short marginal setae coalescing into stout structures; leaf blade abaxial surfaces eglandular or glandular.

6. Inner phyllaries with broadly obtuse to rounded ciliate membranous apex, either much broader than paleae or contrasting texturally with paleae.

7. Leaf surfaces discolorous, abaxial surfaces densely white-strigillose or matted white-tomentulose; disk florets 40–60; (Mexico) ..... **Perymenium klattianum** J.J. Fay

7. Leaf surfaces concolorous, abaxial surfaces sparsely strigillose; disk florets 9–25.

8. Capitulescences corymbiform or corymbiform-paniculate, pluricapitulate; capitula small; involucres 4.5–5.5 mm long, turbinate or narrowly campanulate; disk florets 9–13(–19); paleae 4.2–4.5 mm long; (Mexico, Guatemala) ..... **Perymenium gracile** Hemsl.
8. Capitulescences open cymose, 3–15-capitulate; capitula mid-sized; involucres 6.5–8.5 mm long, campanulate; disk florets ca. 25+; paleae 7–7.5 mm long; (Guatemala) ..... **Perymenium jalapanum** Standl. & Steyerm.

6. Inner phyllaries transitional to paleae, stiffly herbaceous-tipped, apex usually acute to obtuse, not ciliate.

9. Ray florets 4–5, corolla limbs 3–4 mm long; disk florets 6–8; (Mexico) ..... **Perymenium pinetorum** Brandegee
9. Ray florets 6–12, corolla limbs 4–13 mm long; disk florets 15–50.

10. Leaf blades ovate or oval-ovate, veins often more or less immersed abaxially, surfaces eglandular; corollas eglandular; (Mexico, Guatemala) ..... **Perymenium chloroleucum** S.F. Blake
10. Leaf blades lanceolate to lanceolate-ovate, veins often prominent abaxially, abaxial surface usually glandular, corollas sometimes glandular; (Mexico, Guatemala) ..... **Perymenium ghiesbreghtii** B.L. Rob. & Greenm.

Figure 7. Woody trunk of a representative tree of *Perymenium grande* var. *grande* (*Pruski et al. 4479*).

An arborescent Composite from El Salvador with white ray corollas, large capitula, biconvex somewhat compressed to subquadrangular cuneate-based disk cypselae, and a pappus of usually four(–five) slightly to moderately unequal pappus scales is described here as *Podachaenium salvadorense*. The genus *Podachaenium* (Verbesininae) was described by Bentham (1853) and now contains six species, but was thought of historically as monotypic, being represented solely from the well-known white-flowered *P. eminens* (Lag.) Sch. Bip. (Fig. 8).

Figure 8. *Podachaenium eminens* (reproduced from Bot. Mag., ser. 4, 9: tab. 8502. 1913).

Podachaenium eminens is distinctive in its discolorous abaxially glandular 5-angled maple-like leaves, white rays, and attenuate-stipitate cypselae (Fig. 9A–B), and although it contains the generitype, by intermediate pappus squamellae it is atypical in *Podachaenium* and Verbesininae. *Podachaenium eminens* is occasionally cultivated in tropical America as well as in the western United States, but I have seen also a collection (NY) of it made in Florida a century ago by John K. Small. By white ray corollas (Fig. 8) and biconvex(–subquadrangular) cypselae (Fig. 9, 11), *Podachaenium* is accepted as enlarged by Jansen et al. (1982) and as redefined by Turner and Panero (1992). As opposed to *P. eminens*, however, none of other species *Podachaenium* are well-known, nor have any merited much attention outside of synantherology. The species recently added to *Podachaenium* are mostly unlobed concolorous-leaved, have glabrous disk corolla tubes, and cuneate-based disk cypselae (Fig. 9C–D). They appear to be more closely related to each other than to *P. eminens*.

Figure 9. SEM micrographs of disk cypselae (in B a disk floret) of *Podachaenium.* A–B. Representative cypselae of *Podachaenium eminens,* which includes in synonymy the generitype, showing long-tapering fruit base (whence the generic name), two long radial pappus scales, and several small intermediate lateral squamellae. C–D. Cypselae from holotype of *Podachaenium salvadorense*, showing merely cuneate fruit bases, four(–five) unequal pappus scales, and no small intermediate squamellae; the lateral scales represent elongated squamellae and are shorter and more fimbriate than are the radial scales (A–B *Pena 1032*, MO; C–D *Villacorta & Puig 2420*, MO).

PODACHAENIUM SALVADORENSE Pruski, **sp. nov. TYPE: EL SALVADOR. Santa Ana**. Parque Nacional Montecristo, Metapán, orilla del bosque nebuloso, 2230 m, 16 Aug 1996, *R. Villacorta & G. Puig 2420* (holotype: MO; isotype: LAGU). Figs. 5, 9C–D, 10–11.

Figure 10. Holotype of *Podachaenium salvadorense* (*Villacorta & Puig 2420*, MO). A metric scale bar is on upper left.

Arbor a 4 m alta; caules dense hirsuto-pilosa; folia opposita petiolata, lamina 6–14 × 2–5 cm elliptico-ovata eglandulosa et glabrata vel subglabrata; capitulescentia cymosa; pedunculi dense pilosuli vel dense villoso-pilosi (2–)3–8 cm longi; capitula radiata; involucrum 11–15 × 10–17 mm late campanulatum vel hemisphaericum; phyllaria obgradata, 3(–4)-seriata, externa dense hirtella; flosculi radiati 13–16 pistillati, corollis albis, limbo 15–20 × 2–4 mm oblongo 11–13-nervio, glanduloso; flosculi disci circiter 200, corollis circiter 3 mm longis late infundibuliformis luteolis; cypselae 2–2.5 mm longae; aristae pappo (3–)4(–5) , 1–1.5 mm longae, squamellae nullae.

Small trees to 4 m tall, branches sometimes vining; stems densely and persistently hirsute-pilose distally; herbage with trichomes brownish. **Leaves** opposite, petiolate; blade 6–14 × 2–5 cm, elliptic-ovate, unlobed, venation arching plinerved from well above base with 2 pairs of thick secondary veins reaching past mid-blade, tertiary venation not well-developed, adaxial surface glabrous, abaxial surface eglandular, mostly glabrous but with larger veins sometimes substrigose, base narrow-cuneate, margins serrate, apex acuminate; petiole 0.5–1.5 cm long, unwinged. **Capitulescence** open-cymose, 3–6-capitulate; peduncle (2–)3–8 cm long, densely pilosulose to densely villous-pilose. **Capitula** to ca. 15 mm long, hemispherical post-anthesis; involucre 11–15 × 10–17 mm, broadly campanulate or hemispherical; phyllaries erect through anthesis, obgraduate, ca. 3(–4)-seriate, loosely imbricate, flat; outer phyllaries 10–15 × 1–2 mm, herbaceous, densely persistent-hirtellous, oblong-lanceolate, apex obtuse, typically spreading or reflexed; inner phyllaries subtending ray florets usually much smaller and paler than the outer, resembling paleae in color and texture; clinanthium paleate, to 5 mm tall, conical, fistulose post anthesis; paleae ca. 4 mm long, pale with midrib darker and finely glandular from apex to base. **Ray florets** 13–16, pistillate; corolla white, limb 15–20 × 2–4 mm, oblong, 11–13-nerved, glandular abaxially. **Disk florets** ca. 200; corolla ca. 3 mm long, broadly funnelform, yellow, tube ca. 0.7 mm long, glabrous, lobes ca. 0.5 mm long, sometimes sparsely setulose; style exappendiculate, branches with stigmatic surfaces 2-banded. **Cypselae** 2–2.5 mm long, glabrous, black with paler margins and base, the rays triquetrous, the disks somewhat compressed and biconvex to subquadrangular, base cuneate; ray pappus scales 3; disk pappus scales (3–)4(–5), extremely persistent, slightly–moderately unequal, the longer 2 usually ca. 1.5 mm long, the shorter (1–)2(–3) intermediate ones between the longer scales usually ca. 1 mm long and fimbriate-tipped, without intermediate minute fragile squamellae.

Etymology, distribution, and ecology. *Podachaenium salvadorense* is endemic to cloud forests in Parque Nacional Montecristo, El Salvador (whence the epithet) only a few kilometers from the Guatemala–Honduras border. It occurs at about 2200–2300 meters elevation, and flowers in August. It is known only with certainty from the type collection, but from near the type locality I have seen two budding collections (*V. Martínez* 927 and *964*, both MO) that may be *Podachaenium salvadorense*.

By its stems and obgraduate herbaceous phyllaries persistently brown-pubescent, large capitula in open-cymose capitulescences, and leaves with venation arching plinerved from well above base, *Podachaenium salvadorense* is most similar to *P. chiapanum* B.L. Turner & Panero (Fig. 5). *Podachaenium salvadorense* differs most strikingly by its disk pappus usually of four(–five) slightly to moderately unequal long scales (Figs. 9C–D, 11). It appears that in *P. salvadorense* the lateral two(–three) moderately elongated scales represent modified squamellae, and are more fimbriate than are the two true elongated radial scales. The disk cypselae pappus scales in *P. salvadorense* are more or less constant in number, not greatly unequal, and the lateral ones are persistent.

Although intermediates in lateral squamellae elongation between the new species and the very-different-in-pappus-characters *Podachaenium chiapanum* are indeed possible, in the material in front of me no hint of intermediacy has been found, and the new species apparently merits recognition. The pappus characters of *P. salvadorense* nearly bridge the gap (albeit falsely so) in

pappus characters between *Podachaenium* and the earlier yellow-rayed *Tetrachyron* Schltdl. (described in 1847), but *Podachaenium* differs by two true always equally long radial pappus scales, ray corollas always white, and biconvex to subquadrangular cypselae that are never obviously quadrangular.

Also similar to *Podachaenium chiapanum* and *P. salvadorense* is subequally and glabrous-phyllaried *P. standleyi* (Steyerm.) B.L. Turner & Panero (Chiapas and Guatemala, Fig. 5). Wussow and Urbatsch (1978) and Jansen et al. (1982) treated *P. standleyi* in synonymy of *P. pachyphyllum* (Klatt) R.K. Jansen, N.A. Harriman, & Urbatsch, but I follow Turner and Panero (1992) who resurrected *P. standleyi* from synonymy. *Podachaenium salvadorense* is less similar to true *P. pachyphyllum* and the presumably distinct *P. chimalapanum* B.L. Turner, which each occur from Oaxaca northwards and differ by thicker pinnately veined leaves and relatively short outer phyllaries. Lastly, a distribution map (Fig. 5) is given for the similar regional *P. chiapanum, P. salvadorense*, and *P. standleyi*, and a key to species of *Podachaenium* in Mesoamerica is included.

Figure 11. Disk cypselae and florets from holotype of *Podachaenium salvadorense*. (*Villacorta & Puig 2420*, MO). [Scale bar increments are 1 mm].

Key to the Mesoamerican species of *Podachaenium*

1. Leaf blades mostly (3–)5(–7)-angled, palmately 3-veined from near basal acumen, abaxial surfaces tomentose, glandular; disk corolla tubes glandular; cypselae base attenuate-stipitate; (syn.: *P. paniculatum* Benth.); (Mexico to Colombia) ..... **Podachaenium eminens** (Lag.) Sch. Bip.
1. Leaf blades unlobed, venation arching plinerved from well above base, abaxial surfaces mostly glabrous, eglandular; disk corolla tubes glabrous; cypselae base cuneate.

2. Capitulescences corymbiform-paniculate; phyllaries usually subequal to very slightly obgraduate; outer phyllaries stiff-chartaceous, typically glabrous; (Chiapas and Guatemala) ..... **Podachaenium standleyi** (Steyerm.) B.L. Turner & Panero
2. Capitulescences open-cymose; phyllaries obgraduate; outer phyllaries herbaceous, densely persistent-hirtellous.

3. Capitula to ca. 11 mm tall, involucres 6–10 mm long; ray florets ca. 21; disk pappus scales 2, equal, 1–4 minute squamellae between the longer scales; (Chiapas) ..... **Podachaenium chiapanum** B.L. Turner & Panero
3. Capitula to ca. 15 mm tall, involucres 11–15 mm long; ray florets 13–16; disk pappus scales (3–)4(–5), slightly to moderately unequal, without intermediate small squamellae which are represented instead by the 2(–3) elongated lateral relatively fimbriate scales; (El Salvador) ..... **Podachaenium salvadorense** Pruski

A second new species of Heliantheae subtribe Verbesininae is described below as *Verbesina monteverdensis*. In Chiapas and Central America, there are nearly 40 species of *Verbesina*, of which about 22 are either white-rayed or opposite-leaved. The remaining 16 species are alternate-leaved yellow-rayed species as is the new species, which is distinctive in its obgraduate phyllaries and subsquarrose outer phyllaries (Fig. 14).

Because various species of our four regional genera of Verbesininae have been shuffled about, it seems fitting here to provide the below key to the Central American genera of subtribe Verbesininae.

1. Cypselae alate, bases not stipitate; pappus mostly 2–3-awned on margins, faces without intermediate squamellae; (38 regional species from Chiapas into Central America) ..... **Verbesina** L.
1. Cypselae exalate, bases narrowed and stipitate or sometimes cuneate; pappus of 2–10 awns or scales on angles, faces sometimes with intermediate shorter squamellae.

2. Disk cypselae quadrangular; pappus usually of only 4 equal scales; (one regional species from Chiapas into Central America) ..... **Tetrachyron** Schltdl.
2. Disk cypselae somewhat compressed and biconvex(–subquadrangular); pappus of 2–4(–5) awns or of unequally developed scales.

3. Capitula globose or broadly campanulate; ray corollas white; cypsela base stipitate-tapered or cuneate; (four regional species from Chiapas into Central America) ..... **Podachaenium** Benth.
3. Capitula turbinate to narrow-campanulate; ray corollas yellow and cypselae base stipitate-tapered; pappus of 4–10 unequal lacerate aristate scales; (monotypic / unispecific) ..... **Squamopappus** R.K. Jansen, N.A. Harriman, & Urbatsch

VERBESINA MONTEVERDENSIS Pruski, **sp. nov. TYPE**: **COSTA RICA. Puntarenas.** Monteverde, road to TV Tower, 1700 m, 24 Aug 1985, *W. Haber 2373* (holotype: MO; isotype: CR). Figs. 12–15.

Frutex vel arbor 2–8 m alta; caules exalata piloso-hirsuta vel glabrata; folia alterna petiolata, lamina 5–10(–15) × 1.5–3.5 cm lanceolata vel anguste elliptico-ovata pinnatim venosa glabrata vel parce pilosulo-hirsutula; capitulescentia 5–15 cm diam. corymbiformi-paniculata, pedunculi 0.5–3 cm longi; capitula radiata; involucrum 4–5.5 × 4–5(–6) mm campanulatum; phyllaria obgradata 2–3-seriata, externa 5–10 spatulata subsquarrosa; flosculi radiati 8–10 pistillati, corollis luteolis, limbo 5–9 × 2–4 mm ovato vel obovato 5(–7)-nervio; flosculi disci 25–40, corollis 4.5–5.5 mm longis infundibuliformis luteolis; cypselae 2.7–3.7 mm longae; aristae pappo 2, 2.5–3 mm longae.

Figure 12. Holotype of *Verbesina monteverdensis*. (*Haber 2373*, MO).

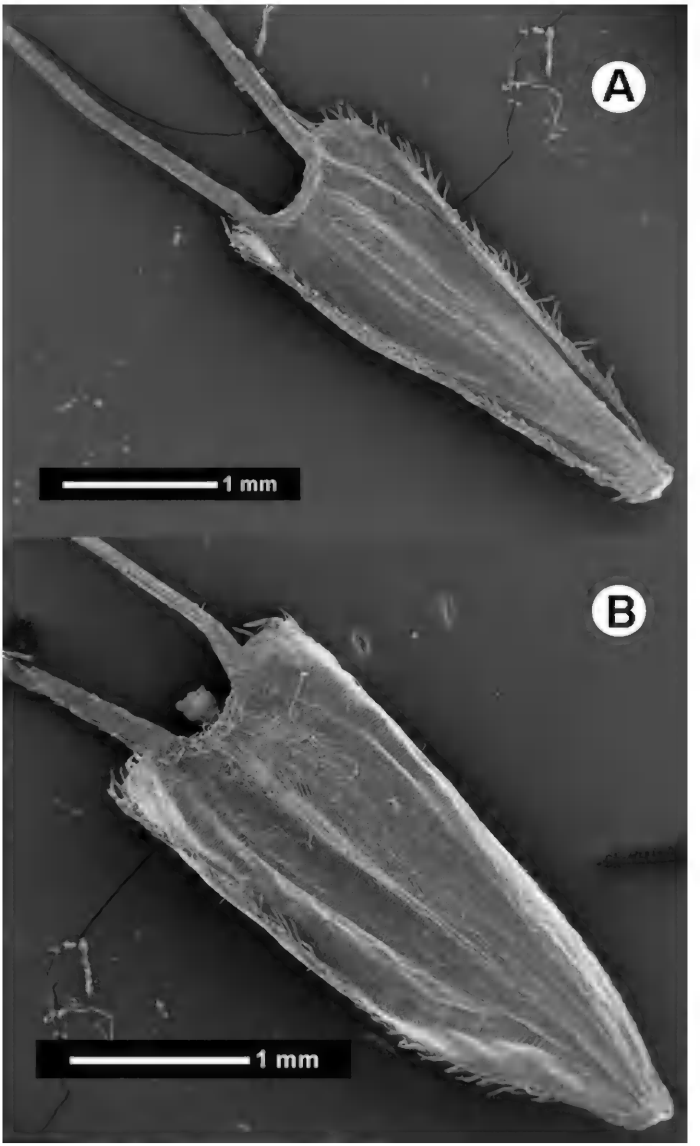


Figure 13. SEM micrographs of narrowly winged immature cypselae of *Verbesina monteverdensis*. (*Gentry et al. 48721*, MO).

Shrubs to trees 2–8 m tall; stems brittle, subangulate proximally to striate-subterete distally, exalate, brownish, sparsely to moderately pilose-hirsute distally to glabrate, trichomes straight, not crisped; herbage mostly glabrous to sparsely pubescent, eglandular. **Leaves** alternate, unlobed,

petiolate; blade 5–10(–15) × 1.5–3.5 cm, lanceolate or narrowly elliptic-ovate, chartaceous, venation pinnate, finely reticulate, secondary nerves 4–6 per side, directed forward, prominulous abaxially, surfaces concolorous, adaxial surface basically glabrous, abaxial surface glabrous or often with larger veins subappressed pilosulose-hirsutulous, base narrowly cuneate to attenuate, sometimes slightly decurrent onto distal portions of the petiole, margins entire to remotely denticulate, apex acuminate to attenuate; petiole 0.5–1.5 cm long. **Capitulescence** terminal 5–15 cm diam., not exserted well above subtending leaves, weakly convex to nearly flat-topped, corymbiform-paniculate, pluricapitulate, proximal branchlets strongly ascending, pilose-hirsute, internal bracteate leaves usually much smaller than main stem leaves; peduncles 0.5–3 cm long, moderately pilose-hirsute. **Capitula** 7–8.5 mm long, 33–50-flowered, radiate; involucre 4–5.5 × 4–5(–6) mm, double with the outer phyllaries resembling the 0–3 distal loosely inserted bracteoles of peduncle, campanulate but phyllaries spreading in fruit, 2–3-seriate; phyllaries obgraduate (infrequently merely subequal); outer phyllaries 5–10, herbaceous, subsquarrose with distal half reflexed, spatulate, (4–)5–6 × 1–1.5 mm, dark-veined, glabrous to sparsely pilosulose, apex acute to narrowly obtuse; inner phyllaries ca. 4 × 1 mm, chartaceous, shorter than both the outer phyllaries and the paleae; clinanthium paleate, flat to weakly convex, ca. 1.5 mm diam.; paleae 5–6 mm long, oblong, conduplicate, sparsely pilose along the midvein, apex acute, often outwardly directed. **Ray florets** 8–10, pistillate; corolla yellow, tube 1–1.5 mm long, sparsely pilosulose, limb 5–9 × 2–4 mm, ovate to obovate, 5(–7)-nerved. **Disk florets** 25–40; corolla 4.5–5.5 mm long, funnelform, yellow, tube 1–1.5 mm long, sparsely pilosulose, lobes 0.5–0.7 mm long, deltate; anthers ca. 1.8 mm long, thecae black but connectives pale; style exappendiculate, branches 1–1.2 mm long, stigmatic surfaces 2-banded. **Cypselae** 2.7–3.7 mm long, body black, with pale narrow wings, faces weakly setose distally but otherwise usually glabrous; pappus awns 2, 2.5–3 mm long.

Paratypes. COSTA RICA. Border of Alajuela, Guanacaste, and Puntarenas. Reserva de Monteverde, Cordillera de Tilarán, bosque enano en cumbre de Divis Continental, 1550–1580 m, 31 Jul 1976, *Dryer 530* (CR, MO). **Puntarenas.** Monteverde Reserve, area around TV towers, lower montane rain forest, 1600 m, 11 Oct 1985, *Bello 3043* (MO); Monteverde Reserva Forestal, sendero nubloso, 1550–1600 m, 21 Aug 1984 (fr), *Gentry & Haber 48721* (CR, MO, UC); Monteverde Cloud Forest Res., secondary thickets along continental divide near radio towers atop Cerro Los Amigos, 1550–1840 m, [label coordinates perhaps incorrect], 27 Feb 1992, *Grayum et al. 10189* (CR, MO, TEX); Monteverde, road to TV tower, 1700 m, 24 Aug 1985, *Haber 2342* (MO, TEX); Reserva Biológica Monteverde, area around TV towers and access road, 10° 19' N, 84° 48' W, 1600–1800 m, 20 Dec 1990, *Haber & Zuchowski 10248* (CR, MO, TEX, UC); Monteverde Reserva Biológica, sin. elev., 8 Aug 1975, *Poveda 1127* (CR, MO); Monteverde Cloud Forest Reserve, Cordillera de Tilarán, Pacific slope of continental divide, 1500–1620 m, 10 Aug 1984, *Pounds 299* (MO).

Etymology, distribution, and ecology. *Verbesina monteverdensis* is known only from montane forests in Monteverde Reserve (whence the epithet) in Costa Rica on the Pacific watershed. It occurs from about 1500–1840 meters elevation, and has been collected in flower in February, July, August, October, and December. The one fruiting only collection in front of me was made in August, which together with the flowing material suggests that this species has a broad flowering period, perhaps only out of flower in the driest months (i.e., March–June) of the year.

Verbesina monteverdensis by its yellow-flowered radiate capitula seems best placed in the *Verbesina* sect. *Saubinetia* sensu Robinson and Greenman (1899b) and Olsen (1985). *Verbesina monteverdensis* stands out in the loosely defined *Verbesina* sect. *Saubinetia* by its obgraduate phyllaries and subsquarrose outer phyllaries. Standley (1938) listed six species in Costa Rica, of which only *V. oerstediana* is alternate-leaved and yellow-rayed. Indeed, specimens of *V. monteverdensis* have generally passed under either *V. lanata* or *V. oerstediana*, and would key to *V. lanata* in D'Arcy (1975).

Figure 14. *Verbesina monteverdensis*, capitulum showing obgraduate phyllaries and subsquarrose outer phyllaries. (From the holotype, *Haber 2373*, MO).

Verbesina lanata was described by Robinson and Greenman (1899b) in *Verbesina* sect. *Saubinetia* and as yellow-flowered, but instead this species has white ray corollas and is a member of *Verbesina* sect *Ochractinia* (Olsen 1985). *Verbesina lanata* does not seem very closely related to the new species. Yellow-rayed Panamanian material called *V. lanata* by D'Arcy (1975) has mostly been referred instead to a broadly defined *V. oerstediana*, which is centered in Costa Rica and Panama, but which perhaps includes in synonymy Honduran *V. vicina* S.F. Blake. *Verbesina oerstediana* has a graduate involucre with non-squarrose phyllaries, as do nearly all Central American species, much unlike *V. monteverdensis*. Further distinguishing *V. monteverdensis* from *V. oerstediana*, but less taxonomically significant, are merely pilosulose (vs. pilose) corolla tubes, and herbage glabrous to weakly pubescent with straight trichomes (vs. mostly tomentulose to tomentose with crisped trichomes), smaller leaves, and smaller capitulescences with fewer, smaller capitula. While the pubescence character seems striking, Blake (1938) noted Costa Rican *V. oerstediana* var. *glabrior* S.F. Blake is unusually glabrous to weakly pubescent. However, in technical feature Blake's variety matches *V. oerstediana* and lacks the obgraduate phyllaries and subsquarrose outer phyllaries that distinguishes the new species.

Costa Rican and Panamanian alternate-leaved yellow-rayed species described since Standley (1938) but not sufficiently distinct from *Verbesina monteverdensis* include: *V. baruensis* Hammel & D'Arcy, which has ovate, truncate-based leaves and capitula twice the size of the new species; and *V. fuscasiccans* (D'Arcy) D'Arcy and *V. tapantiana* Poveda & Hammel, each of which are winged-petiolate nearly to stem and subsessile-leaved. Costa Rican *V. trichantha* (Kuntze) S.F. Blake is yellow-flowered but discoid-capitulate, otherwise distinguished by its disk corolla lobes longer than throat, and is unlike any other regional species. *Verbesina trichantha* is known only from the type. Among other regional alternate-leaved yellow-rayed species, *V. monteverdensis* is similar to *V.*

eperetma in the subsquarrose involucre character, and by narrow leaves to *V. chiapensis* B.L. Rob. & Greenm. and *V. perymenioides* Sch. Bip. ex Klatt, but these three species occur only from Guatemala northwards into Mexico (Nash 1976; Strother 1999), and otherwise do not seems too similar to *V. monteverdensis*. Finally, a few regional alternate-leaved yellow-rayed Verbesinas are variously annuals, winged-stemmed, large-leaved, discolorous-leaved, winged petiolate, large-capitulate, long-rayed, or sterile-rayed, and each seems distant to *V. monteverdensis*.

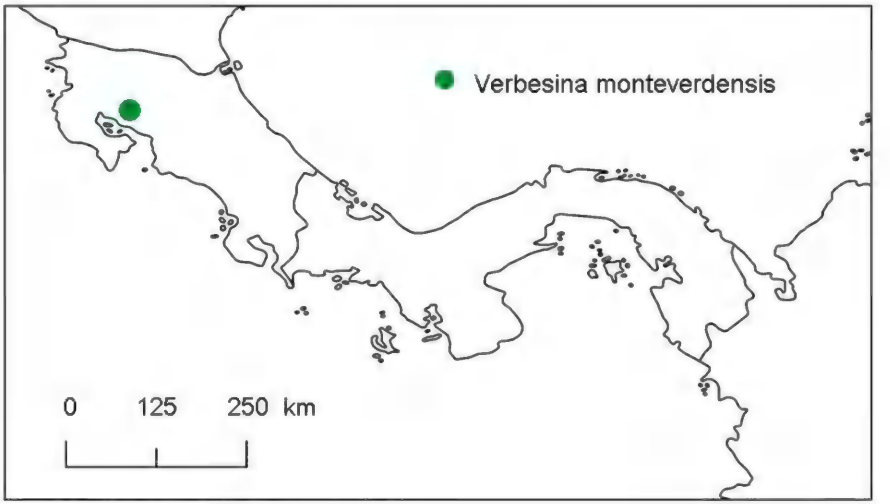


Figure 15. Distribution of *Verbesina monteverdensis*.

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COMPOSITAE OF CENTRAL AMERICA–V. THE GENUS *BRICKELLIA* (EUPATORIEAE) IN COSTA RICA

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ABSTRACT

A synopsis of *Brickellia* (Compositae: Eupatorieae) in Costa Rica is provided and includes the report of *Brickellia kellermanii* as a new record both for Costa Rica and El Salvador. Images of each Costa Rican species (*B. argyrolepis*, *B. diffusa*, and *B. kellermanii*) are given, and generically important features of *Brickellia* are illustrated. As in previous classifications, *B. argyrolepis* and *B. kellermanii* are placed into *Brickellia* sect. *Bulbostylis* A. Gray (a nom. nov. at the sectional rank for *Bulbostylis* DC. non Steven), which by lectotypification includes the homotypic synonym *Brickellia* sect. *Coleosanthus*; and *B. diffusa* is placed in *Brickellia* sect. *Leptanthodium* B.L. Rob.

The American genus *Brickellia* Elliott is a species-rich, traditionally recognized genus of Compositae tribe Eupatorieae (Bentham & Hooker 1873; Gray 1884; Robinson 1913). *Brickellia* may be recognized most readily by its (4–)8–10-costate fruits (Fig. 5) and setose nodal stylopodium (Figs. 1C, 5). Other features useful in distinguishing *Brickellia* from other Costa Rican Eupatorieae (Standley 1938; King and Robinson 1987) are its involucre with all phyllaries persistent (Fig. 6D), shortly lobed funnelform corollas (Fig. 5), anthers with collar about as wide as the filaments and with appendage longer than wide with an obtuse to rounded apex (Fig. 1A), anther collar cells slightly annular-thickened, anther endothecial tissue transitional with irregular thickenings on both transverse and vertical cell walls (Fig. 1B), and a pappus of many capillary bristles (Fig. 5).

Brickellia was revised a century ago by Robinson (1917), who recognized 91 species, these mostly centered in Mexico. King and Robinson (1987) in their generic monograph of tribe Eupatorieae recognized 98 species in the genus. More recently, Pruski (1997) estimated as 98–110 the number of species in *Brickellia*, Turner (1997) gave as 90 the number, with "about 78 of these native to Mexico," and Scott (2006) recognized about 100 species, with 32 found in the United States. Schilling et al. (2015) sectionally placed 97 species, synonymized *Barroetea* A. Gray and *Phanerostylis* (A. Gray) R.M. King & H. Rob., and pointed out that 31 of B.L. Robinson's 91 recognized species have since been synonymized or removed.

The number of species of *Brickellia* diminishes southeastward throughout Central America, with Dillon et al. (2001) treating five species in Nicaragua, Standley (1938) recording only *B. argyrolepis* B.L. Rob. and *B. diffusa* (Vahl) A. Gray in Costa Rica, and King and Robinson (1975) citing only *B. diffusa* in Panama, although *B. argyrolepis* was subsequently reported in Panama by

D'Arcy (1987a, 1987b). We recognize here three species of *Brickellia* in Costa Rica: the two treated by Standley (1938) as well as *B. kellermanii* Greenm., which is reported as new for Costa Rica and also as new for El Salvador.

Two of our Costa Rican species, *Brickellia argyrolepis* and *B. kellermanii*, were placed by Robinson (1917) in *Brickellia* sect. *Bulbostylis* A. Gray (1852), a sectional name that by ICN Art. 58.1 is a nom. nov. (avowed substitute) for the generic name *Bulbostylis* DC., non Steven. Schilling et al. (2015) also treated *B. argyrolepis* and *B. kellermanii* (albeit there implicitly in synonymy with *B. oliganthes* (Less.) A. Gray) as consectional. Our third Costa Rican species, *B. diffusa*, was placed in *Brickellia* sect. *Leptanthodium* B.L. Rob. by each Robinson (1917) and Schilling et al. (2015). In the abbreviated generic synonymy below, nomenclatural status (when either a homonym, conserved name, or rejected name) of genera is indicated, and in the sectional nomenclator and species key that follow the genus description, the sectional dispositions (following Robinson 1917 and Schilling et al. 2015) of the three Costa Rican species are indicated.

BRICKELLIA Elliott (1823, nom. cons., non *Brickellia* Raf. 1808, hom. rej.). **TYPE:** *Brickellia cordifolia* Elliott.

Barroetea A. Gray, *Bulbostylis* DC. (1836, hom. illeg. et rej., non Steven 1817, nom. rej., nec Kunth 1837, nom. cons.), *Clavigera* DC., *Coleosanthus* Cass. (1817, nom. rej.), *Ismaria* Raf., *Kuhnia* L. (1763, nom. rej.), *Phanerostylis* (A. Gray) R.M. King & H. Rob., *Rosalesia* La Llave.

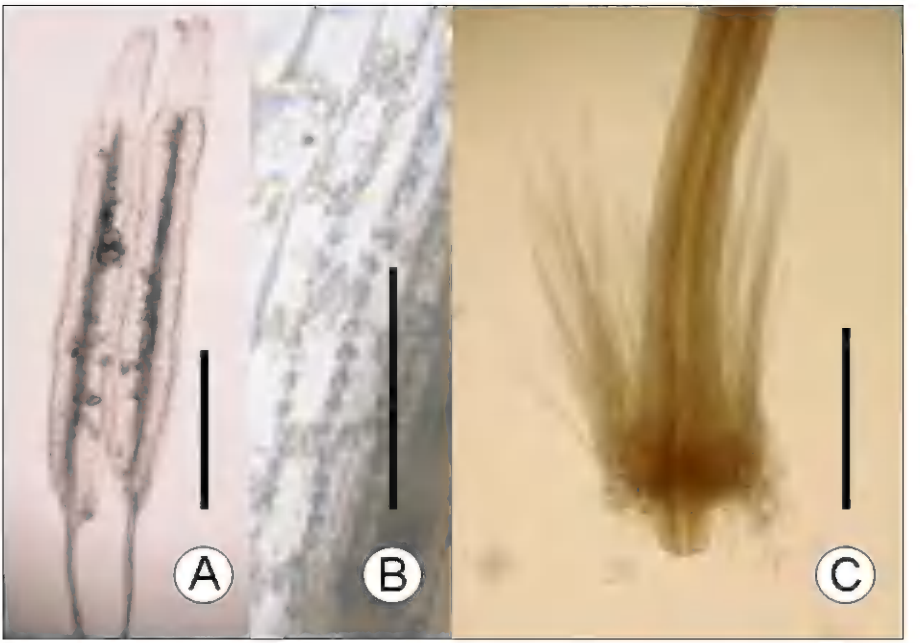

Figure 1. Floral microcharacters of *Brickellia diffusa*, characteristic of the genus. A. Anthers showing slender collar and long apical appendage with an obtuse apex. B. Endothecial tissue transitional showing irregular thickenings on both transverse and vertical cell walls. C. Long-setose nodular stylopodium. All from *Pruski, Ortiz & Martínez 4196*, MO. [scale bars: A 0.2 mm, B 30 µm, C 0.2 mm].

Annual or perennial herbs to shrubs. **Leaves** opposite or alternate, petiolate or sessile; blade commonly puberulent or glandular, 3-veined from near base, margins usually dentate. **Capitulescence** usually terminal and thyrsoid-paniculate. **Capitula** discoid, sessile to long-pedunculate; involucre narrowly cylindrical to campanulate; phyllaries subimbricate, graduate, 3–5-seriate, narrow, mostly relatively thin-textured, pale-costate, persistent; clinanthium epaleate. **Ray florets** 0. **Disk florets** bisexual; corolla funnelform, shortly 5-lobed, usually white to ochroleucous, corolla lobe surfaces smooth; anther collar slender, about as wide as filaments, collar cells typically with indistinct transverse bead-like annular thickenings, endothecial tissue transitional with irregular thickenings on both transverse and vertical cell walls, apical appendage longer than wide, apex obtuse to rounded, never truncate; style trunk with two vascular traces, stylopodium enlarged (nodular), long-setose, setae unicellular, style branches narrowly clavate, appendage about as long as or longer than proximal stigmatic portions of branch. **Cypselae** (4–)8–10-costate, setulose, black with rimmed tan carpopodium; pappus of many elongate isomorphic persistent barbellate(–plumose) capillary bristles. $x = 9$.

The two sections of *Brickellia* in Costa Rica

1. **BRICKELLIA SECT. BULBOSTYLIS** A. Gray, Smithsonian Contr. Knowl. 3(5): 84. 1852, as "§ *Bulbostylis*." Replaced name: *Bulbostylis* DC., Prodr. 5: 138. 1836, non Steven 1817, nec Kunth 1837. [The sole infrageneric rank used by Gray (1852) is section, and in *Laphamia* A. Gray (1852: 99) both the word 'section' and symbol '§' are used and equated. The Asa Gray avowed substitute name is thus not an unranked infragenus.]. **LECTOTYPE** (King and Robinson, Sida 3: 332. 1969): *Coleosanthus cavanillesii* Cass. (= *Brickellia cavanillesii* (Cass.) A. Gray).

Brickellia sect. *Coleosanthus* (Cass.) E.E. Schill. & R. Scott, Phytotaxa 234: 154. 2015, nom. superfl. Basionym: *Coleosanthus* Cass., Bull. Sci. Soc. Philom. Paris 1817: 67. 1817. [This name is nomenclaturally superfluous and homotypic with the earlier *Brickellia* sect. *Bulbostylis*, a name which should have been adopted (ICN Art. 52.1).]. **LECTOTYPE** (King and Robinson, Sida 3: 333. 1969): *Coleosanthus cavanillesii* Cass. (= *Brickellia cavanillesii* (Cass.) A. Gray).

Species in Costa Rica: *Brickellia argyrolepis* B.L. Rob., *Brickellia kellermanii* Greenm.

2. **BRICKELLIA SECT. LEPTANTHODIUM** B.L. Rob., Mem. Gray Herb. 1: 24. 1917. **LECTOTYPE** (Schilling et al., Phytotaxa 234: 155. 2015): *Eupatorium diffusum* Vahl (= *Brickellia diffusa* (Vahl) A. Gray).

Species in Costa Rica: *Brickellia diffusa* (Vahl) A. Gray.

The most common species in Costa Rica is the annual herb *Brickellia diffusa* (Figs. 1, 3). It also is the most widespread species of *Brickellia* in the neotropics. Less common are two perennial species, of which the relatively rare *B. kellermanii* (Figs. 4–6) is known in Costa Rica from a single collection made in Guanacaste. The relatively well-collected *B. argyrolepis* (Figs. 2, 4) is typified by seven syntype collections from Costa Rica, known in four provinces, and represented in Costa Rica by more than two dozen collections. Robinson (1917) placed both *B. argyrolepis* and *B. kellermanii* in *Brickellia* sect. *Bulbostylis*, but in different subsections, which he distinguished by relative petiole lengths.

Of the six species of *Brickellia* known in Central America (viz Williams 1976; King and Robinson 1987), only *B. scoparia* (DC.) A. Gray, diagnosed by its narrowly lanceolate leaves, is not expected in Costa Rica. Both *B. glandulosa* (La Llave) McVaugh and *B. paniculata* (Mill.) B.L. Rob. should be looked for in Costa Rica; they are known to occur from Mexico southeastwards into

Nicaragua (King and Robinson 1987; Dillon et al. 2001), and by moderately chartaceous ovate leaves both would key below to or near *B. argyrolepis*. As an aside we should mention that it seems likely that the citation by Turner (1997) of *B. cavanillesii* in Chiapas is in reference to material we would determine as *B. paniculata*. *Brickellia glandulosa* and *B. paniculata* are distinguished from *B. argyrolepis* by their stipitate-glandular peduncles, and *B. glandulosa* further distinguished by its outer more herbaceous phyllaries about half as long as the inner.

Key to species of *Brickellia* in Costa Rica

1. Annual herbs; stems usually glabrous; capitula 6–8 mm long; phyllaries 2-costate; (*Brickellia* sect. *Leptanthodium* B.L. Rob.) ..... 2. **Brickellia diffusa** (Vahl) A. Gray
1. Subshrubs or shrubs; stems pubescent; capitula 12–16 mm long; phyllaries mostly 5–8-costate; (*Brickellia* sect. *Bulbostylis* A. Gray).

2. Leaf blades ovate to cordiform, moderately chartaceous, not prominently reticulate, margins crenate-dentate; petioles mostly 1–5 cm long; disk florets 20–25; involucres 12–14 mm long ..... 1. **Brickellia argyrolepis** B.L. Rob.
2. Leaf blades lanceolate or elliptic-ovate to oblong, rigidly chartaceous or subcoriaceous, strongly reticulate, margins subentire to crenulate; petioles 0.1–0.5 cm long; disk florets 10–14; involucres 10–12 mm long ..... 3. **Brickellia kellermanii** Greenm.

1. BRICKELLIA ARGYROLEPIS B.L. Rob., Mem. Gray Herb. 1: 90. 1917. **SYNTYPES: COSTA RICA. Cartago**. Agua Caliente, 1190 m, Apr 1894, *J.D. Smith 4859* (GH, K, US). **Heredia.** San Rafael, sin. elev., 13 Feb 1890, *Pittier (Tonduz) 1980* (CR, GH, US). **San José.** Forêts de San Marcos, 1355 m, Mar 1893, *Tonduz 7719* (as "*7710*" in protologue) (MO); Environs de San Marcos, 1355 m, Mar 1893, *Tonduz 7762* (CR, GH, US); Ad Copey, 1800 m, Mar 1898, *Tonduz 11847* (CR, GH); Ad San José, 1160 m, 3 Apr 1909, *Tonduz 17465* (GH). **Without specific locality**. Sin. elev., Apr 1910, *Worthen s.n.* (MO-47689). The collector given on a few sheets as 'Pittier' has been changed en sched. to 'Tonduz.' The identity of the species is not in doubt, none of the seven cited syntype collections are mixed with other species, and although *Tonduz 17465* (GH) is annotated (but perhaps not published) as the lectotype, lectotypification is not needed taxonomically. Figures 2, 4.

Brickellia adenocarpa B.L. Rob., *Brickellia guatemalensis* B.L. Rob., *Coleosanthus adenocarpus* (B.L. Rob.) Arthur

Shrubs 1–3 m tall; stems puberulent or hirtellous distally. **Leaves** opposite, petiolate; petiole mostly 1–5 cm long; blade mostly 3–12 × 2–7 cm, ovate to cordiform, moderately chartaceous, base broadly obtuse or rounded to subcordate, apex acute, not prominently reticulate, surfaces hirtellous to densely villous-pilose, abaxial surface punctate-glandular, margins crenate-dentate. **Capitulescence** of several few-capitulate convex to rounded corymbiform clusters; peduncles somewhat stiff but capitula sometimes nutant, short, pilose, not stipitate-glandular. **Capitula** 14–16 mm long; involucre cylindrical in young flower but quickly becoming broadly turbinate to campanulate, 12–14 mm long; phyllaries 6–7-seriate, strongly and evenly graduate with inner phyllaries twice as long as the outer ones, ovate to lanceolate, chartaceous, mostly 5–7-costate, hirsute, apex acute. **Disk florets** 20–25; corolla 7–9 mm long. **Cypselae** 4.5–6 mm long, spreading setose-pilose, also glandular; pappus bristles 7–9 mm long. $2n = 18$.

Representative specimens examined. COSTA RICA. Alajuela. Cinco Esquinas de Carrizal, 2000 m, 3 Feb 1966, *Jiménez 3656* (CR, F, MO); 2 km southwest of Zarcero, 1890 m, 30 Jan 1972, *King 6431* (CR, MO, NY, US). **Cartago**. Volcán Irazú, camino a Prusia, 3300–3400 m, 1 May 2003, *Alfaro & Quirós 4257* (CR, MO); Entre Cot y Tierra Blanca, 2060 m, 19 Feb 1997, *Rodríguez et al.*

2011 (CR, MO). **Heredia.** Santa Barbara, Río Los Ahogados, 1500 m, 13 Jun 1950, *León 2538* (CR). **San José.** Along Quebrada Cima, 1.5 km NE of Copey, 1960 m, 27 Feb 1990, *Grayum et al. 9693* (CR, MO); Villa Rancho Redondo, 1800 m, 14 Feb 1967, *Weston 4304A* (MO, UC).

Distribution and ecology. *Brickellia argyrolepis* ranges from Mexico southeastwards into Panama. In Costa Rica *B. argyrolepis* occurs mostly in disturbed vegetation and in montane forest (infrequently in premontane forest and páramo) between 1100–2800(–3400) meters elevation in the central portion of the country, especially in Cordillera Volcánica Central and Cordillera de Talamanca. The species usually flowers from January to May.

Williams (1976) treated *Brickellia argyrolepis* and *B. guatemalensis* B.L. Rob. as synonyms of stipitate-glandular *B. paniculata*, and noted that the type of *B. argyrolepis* was "not specified." Clewell (1975), King and Robinson (1987), and Turner (1997) recognized pilose-peduncled *B. argyrolepis* as distinct, with *B. guatemalensis* treated in synonymy of it. By its stipitate-glandular peduncles and non-leafy involucre, *B. adenocarpa* var. *glandulipes* B.L. Rob. is excluded from synonymy with *B. argyrolepis* and here placed in synonymy with *B. paniculata*. Klatt (1892: 196; 1896: 283) cited *B. hartwegii* A. Gray in Costa Rica based on *Pittier 1980*, *Tonduz 7719*, and *Tonduz 7762*, but Robinson (1917) cited each as *B. argyrolepis*, and King and Robinson (1987) gave *B. hartwegii* as a synonym of extra-Costa Rican *B. paniculata*.

Figure 2. Syntype of *Brickellia argyrolepis* (*Worthen s.n.*, MO-47689).

2. **BRICKELLIA DIFFUSA** (Vahl) A. Gray, Smithsonian Contr. Knowl. (Pl. Wright. I) 3(5): 86. 1852. *Eupatorium diffusum* Vahl, Symb. Bot. 3: 94. 1794. *Bulbostylis diffusa* (Vahl) DC., Prodr. 7: 268. 1838. *Coleosanthus diffusus* (Vahl) Kuntze, Revis. Gen. Pl. 1: 328. 1891. **TYPE: AMERICA MERIDIONALI.** Sin. loc., *Anon.* (holotype: C, IDC microfiche set 2201). Although the subtitle of Vahl's Symbolae Botanicae mentions the plants as collected by Forsskal, for *B. diffusa* this appears not to be the case, as the plant is American but Forsskal never collected in the Americas. The type instead may be a gathering of von Rohr. Figures 1, 3.

Chondrilla rhombifolia (Humb. ex Willd.) Poir., *Eupatorium leptopodum* Gardner, *Eupatorium trichosanthum* A. Rich., *Prenanthes rhombifolia* Humb. ex Willd.

Much-branched annual herbs 0.3–1(–2) m tall; stems usually glabrous. **Leaves** opposite becoming alternate in capitulescence, long-petiolate; petiole 1–7 cm long; blade mostly 4–10 × 3–6.5 cm, broadly ovate, thin-chartaceous, surfaces glabrous or glabrous but with abaxial surface also sometimes punctate-glandular, base broadly obtuse to subcordate with basal acumen, margins crenate-dentate. **Capitulescence** a much-branched diffuse pluricapitulate panicle; peduncles filiform, glabrous. **Capitula** 6–8 mm long; involucre 6–7.5 mm long, cylindrical to narrowly turbinate; phyllaries 2–3-seriate, evenly graduated, all ≤ 1 mm diam., linear-lanceolate to lanceolate, scarious-chartaceous, 2-costate, glabrous, outer 1–2 mm long, inner 6–7.5 mm long. **Disk florets** 5–14; corolla 4–5.5 mm long. **Cypselae** 1–2 mm long, appressed-setulose; pappus bristles 4–5 mm long. $2n = 18$.

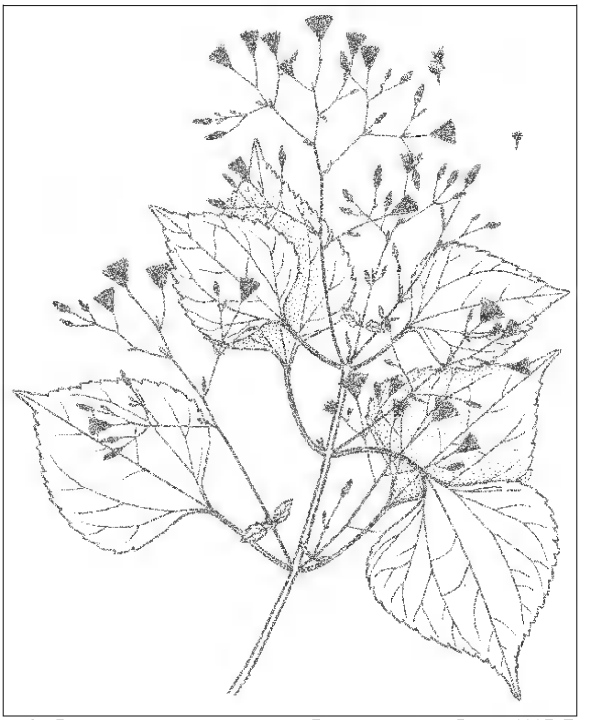

Figure 3. *Brickellia diffusa* line drawing. Reproduced from Pruski 1997, Fig. 175.

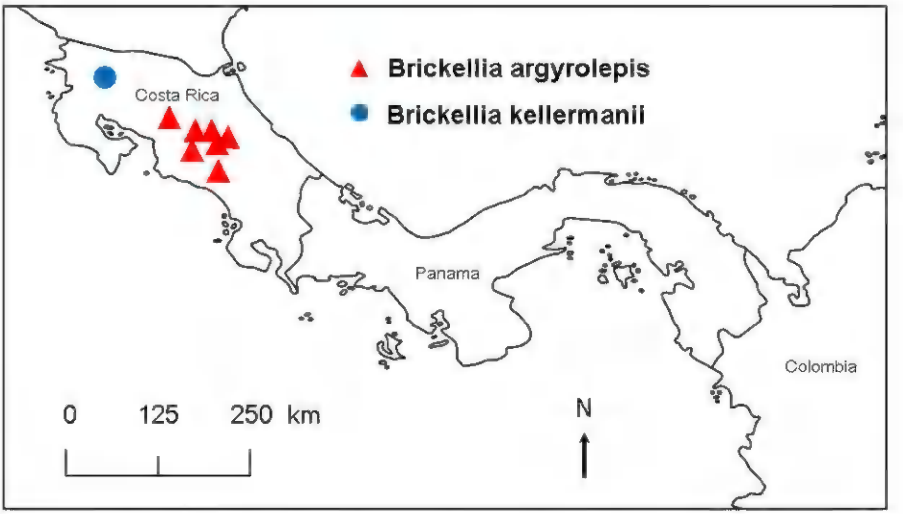

Figure 4. Distributions of *Brickellia argyrolepis* and *Brickellia kellermanii* in Costa Rica. *Brickellia diffusa* is not plotted, but is common throughout much of Costa Rica, especially on the Pacific watershed.

Representative specimens examined. COSTA RICA. Guanacaste. 30 km NW of Liberia, 0–320 m, 24 Dec 1981, *Janzen 12128* (MO); Parque Nacional Santa Rosa, entre la Casona y entrada, 300 m, 27 Feb 1996, *Morales 5312* (CR, MO); Nicoya, 1 Feb 1900, *Tonduz 13604* (CR). **Heredia**. Alrededores de Heredia, 1140 m, 25 Dec 1930, *Brenes 13269* (CR, NY); Belén, 972 m, 27 Jan 2010, *Solano 6129* (CR, MO). **Puntarenas.** Península de Nicoya, Playa Organos y alrededores, 10–100 m, 6 Feb 1993, *Hammel 18790* (CR, MO, TEX); Buenos Aires, Río Ceibo, 200 m, 1 Jan 1892, *Tonduz 4928* (CR). **San José**. Santa Eduviges de Escazú, 1150 m, 17 Feb 1990, *Grayum 9680* (CR, MO, TEX); Vicinity of El General, 640 m, Jan 1939, *Skutch 3988* (MO, NY, US).

Distribution and ecology. *Brickellia diffusa* is common in Costa Rica in disturbed vegetation and in dry, humid, and premontane forests mostly on the Pacific watershed from sea level to about 1200 meters elevation. The species flowers in Costa Rica mostly from December to February. *Brickellia diffusa* is widespread in the Americas and is found from Mexico and the West Indies southwards to Argentina and Paraguay.

3. BRICKELLIA KELLERMANII Greenm., Publ. Field Columbian Mus., Bot. Ser. 2: 265. 1907. **TYPE: GUATEMALA. Baja Verapaz**. Sierra de Las Minas, 1160 m, 3 Mar 1907, *Kellerman 6127* (holotype: F; isotype: OS). Figures 4–6.

Brickellia kellermanii fo. *podocephala* B.L. Rob.

Stiffly erect subvirgate subshrubs 0.6–1 m tall; stems densely hirsutulous-hirtellous, the few lateral branchlets strongly ascending. **Leaves** opposite basally but mostly alternate distally, stoutly short-petiolate; petiole 0.1–0.5 cm long; blade lanceolate or elliptic-ovate to oblong, 1–5.5 × 0.4–2.3 cm, rigidly chartaceous or subcoriaceous, strongly reticulate, surfaces slightly discolorous, pilosulose or tomentulose, sparsely punctate-glandular, base and apex more or less obtuse, margins subentire to crenulate. **Capitulescence** of several leafy branches with paucicapitulate corymbiform-cymes or axillary clusters; peduncles stiff with capitula erect, much shorter than to much longer than

capitula, hirtellous. **Capitula** 12–14 mm long; involucre broadly turbinate to campanulate, 10–12 mm long; phyllaries 5–6 series, strongly graduated, ca. 1.5 mm diam., stiff-chartaceous, oblong to lanceolate, apex apiculate or cuspidate, the outer ones broadly ovate, ca. 2 mm long, 6–8-costate, puberulent and glandular, mid-series ones sometimes slightly herbaceous in the mid zone but with margins obviously hyaline, evenly grading to the inner ones linear-lanceolate, to ca. 12 mm long. **Disk florets** 10–14; corolla 5.5–6 mm long. **Cypselae** 3–3.5 mm long, densely spreading setose; pappus bristles 6–7 mm long.

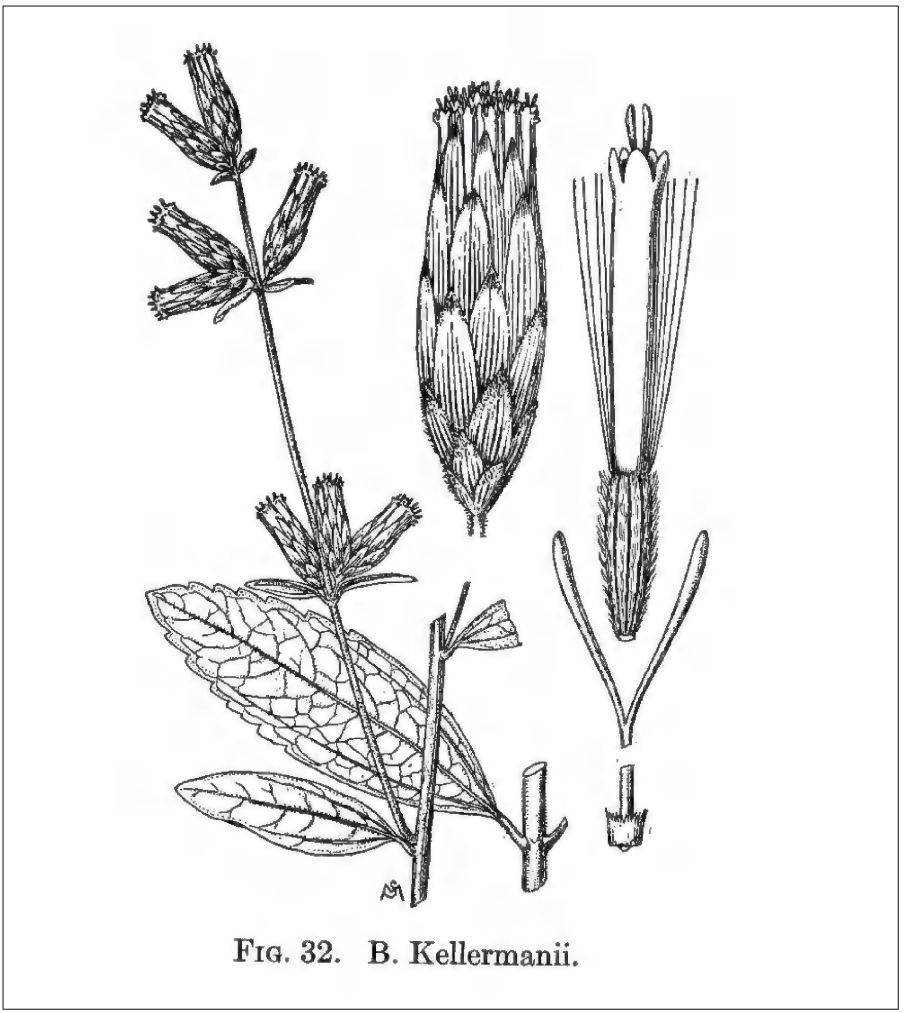

Figure 5. *Brickellia kellermanii* line drawing. Reproduced from Robinson 1917, Fig. 32.

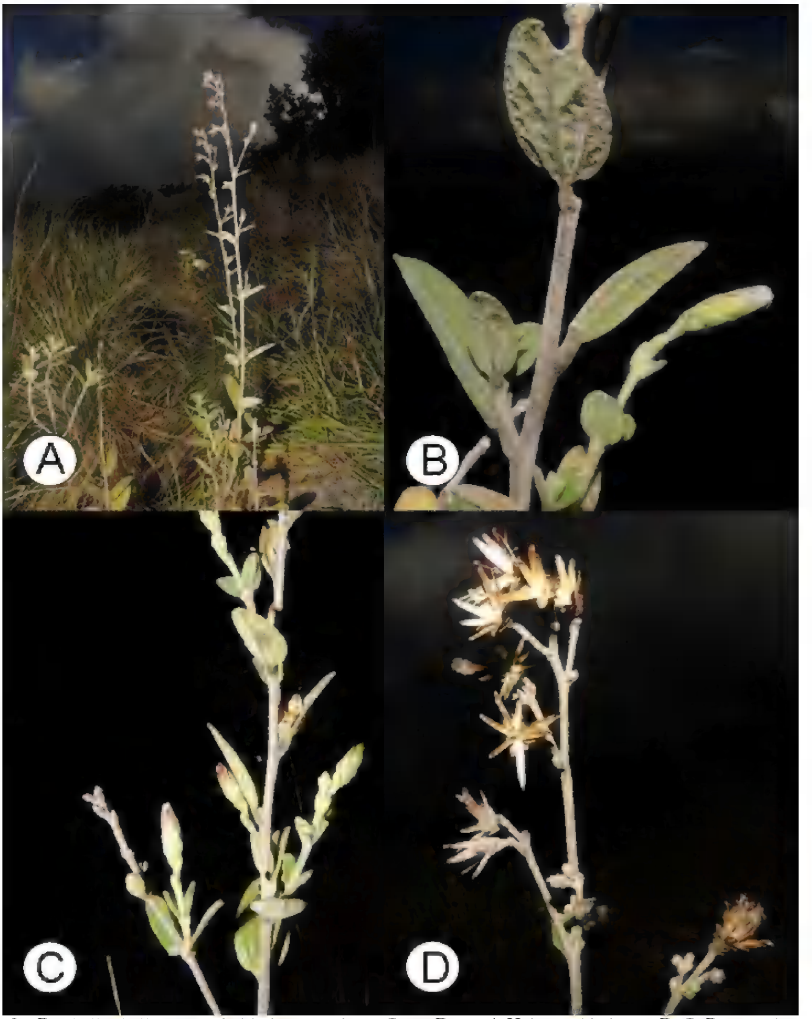

Figure 6. *Brickellia kellermanii*, field photographs in Costa Rica. A Habit and habitat. B–C. Proximal portions of capitulescence. D. Late-fruiting infructescence showing spreading persistent phyllaries. All from *Jiménez et al. 2107*, photographs by J.E. Jiménez.

Voucher collections. **COSTA RICA.** **Guanacaste**. Cantón Bagaces, distrito La Fortuna, Zona Protectora Volcán Miravalles, Sabanas Miravalles (Sitio Miravalles), 988 m, 15 Apr 2013, *Jiménez et al. 2107* (CR, MO, USJ). **EL SALVADOR.** **La Unión.** Reserva Natural de Conchagua, 1027–1150 m, 1 Dec 2006, *Morales et al. 14470* (LAGU). **Santa Ana.** Entre Cerro Peña del Cuervo y el Cerro El Yupe, 6 km NE Candelaria de la Frontera, 1300 m, 9 Dec 1994, *Linares y Martínez 2150* (MO); Cumbre de Cerro Peña del Cuervo, 1298 m, 7 Feb 2016, *Rodríguez & Corrales 5587* (LAGU), *5588* (LAGU).

Distribution and ecology. *Brickellia kellermanii* is newly documented in Costa Rica and is known to us from only a single collection made by the second author in the northwestern part of the country. The occurrence of *B. kellermanii* in El Salvador, originally based on a 1995 determination by José Linares (en sched. MO), also represents a new record for that country (viz Berendsohn and Araniva de González 1989). Its occurrence in Costa Rica and El Salvador was not fully unexpected, however, as the species was known previously in nearby Nicaragua, Honduras, Guatemala, Belize, and Chiapas (Carlson 1954: 397; Clewell 1975; Dillon et al. 2001; King and Robinson 1987; Robinson 1917; Williams 1976). For example, in El Salvador where collected by José Linares and also by the third author, *B. kellermanii* occurs within 15 kms of the frontiers of each Guatemala and Nicaragua. In Costa Rica, *B. kellermanii* was found flowering in April on grassy slopes near Volcán Miravalles. Volcán Miravalles is northwest of Laguna Arenal and is the highest peak (2028 meters) on the Cordillera de Guanacaste, the watershed of which basically forms the line between Alajuela and Guanacaste, but *Jiménez et al. 2107* was made at 988 meters elevation on the volcano's lower drier western slope.

We recognize *Brickellia kellermanii* in the strict sense as in Robinson (1917), Clewell (1975), Williams (1976), and King and Robinson (1987). The peduncle length may vary greatly within a single collection, and the extreme in peduncle length used to define *B. kellermanii* fo. *podocephala* is apparently not useful taxonomically. Although *B. kellermanii* fo. *podocephala* is typified by Nicaraguan material (*Friedrichsthal 1195* collected in the 1840s near Tinotepe and labeled as from Guatemala) it seems not to have been treated in Dillon et al. (2001). We note that Turner (1997) and Dillon et al. (2001) treated *B. kellermanii* in synonymy of the admittedly very similar *B. oliganthes*, a species that in the strict sense is endemic to Mexico and appears to differ by its longer-petiolate leaves and much larger capitula with outer phyllaries herbaceous to the very narrowly hyaline margins. Turner (1997) also treated *B. verbenacea* (Greene) B.L. Rob. in synonymy of *B. oliganthes*, whereas McVaugh (1984) and King and Robinson (1987) recognized *B. verbenacea* as distinct. McVaugh (1984) noted, however, that all species of *Brickellia* sect. *Bulbostylis* subsect. *Reticulatae* B.L. Rob. are "much alike."

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MONOGRAPH OF *HARRISIA* (CACTACEAE)

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ABSTRACT

The biology, taxonomy, and nomenclature are summarized for the 19 species of *Harrisia* recognized here. The genus consists of shrubs and trees native to South America, the West Indies, and Florida (USA). *Harrisia* produces large, nocturnal, ephemeral flowers and is further characterized by its distinctive seed and trichome morphology. The species of the Gran Chaco region and Brazil have the widest distributions, while the species of the Andes and Caribbean region are each confined to comparatively small areas. One species is known only from cultivation. An identification key to the 19 species and color photos, including habit and detail, are provided for all.

Harrisia comprises 19 species occurring in west-central and eastern South America, the Greater Antilles, the Bahamas, and Florida (USA), and one species is known only from cultivation (Table 1; Figs. 1–3). They are spiny, columnar cacti with elongate, indeterminate stems and large, nocturnal, ephemeral flowers. The genus is most easily characterized by its seed morphology with enlarged apical testa cells and a cavernous hilum-micropylar region (Fig. 4) as well as the scaly long trichomes on flowers and fruit areoles (Fig. 5). Within the Cactaceae, the genus is placed within subtribe Trichocereinae (sensu Nyffeler & Eggli 2010) of tribe Cereeae of subfamily Cactoideae. *Harrisia* likely originated in the east-central Andes some time around 3–7 Ma ago with the modern species forming ~0.2–1.5 Ma ago (Franck et al. 2013a, 2013b).

Two subgenera, four sections, and two series are recognized within *Harrisia* (Table 2). The southern range of *Harrisia* is represented by subg. *Eriocereus* (Fig. 1) and contains two sections. Sect. *Roseocereus* is endemic to Bolivia and contains one species, *H. tetracantha*. Sect. *Eriocereus* contains five closely related species in the Gran Chaco region (Argentina, Bolivia, Brazil, Paraguay, and Uruguay) and one known only from cultivation, *H. jusbertii*. The northern range of *Harrisia* is represented by subg. *Harrisia* and is divided into two sections. Sect. *Adscendentes* is endemic to northeast Brazil (Fig. 2) and contains one species, *H. adscendens*. Sect. *Harrisia* occurs in the West Indies (Fig. 3) and is further divided into two series. Ser. *Earlei* is monotypic containing only *H. earlei*, confined to western Cuba. Ser. *Harrisia* consists of 10 closely related species distributed in Florida and throughout the West Indies except the Lesser Antilles.

Even with the information presented here, much remains to be learned concerning *Harrisia*. Characterization of more flowers from various populations across the range of many species is needed. Some descriptions below are based on the observation of one or few flowers. Species relationships have not been fully elucidated and knowledge of them would benefit from intensive sampling for molecular analyses.

This monograph is intended to supersede and replace the draft monograph found in Chapter 4 of my dissertation (Franck 2012a). This present monograph has been extensively altered and revised from the draft in my dissertation, notably including additional information and discussions, updates, many corrected errors, and an abundance of color photographs. It should be noted that the prior dissertation (Franck 2012a) is not considered effective publication with respect to nomenclature (McNeill et al. 2012: Art. 30.8). When no person is named or no reference is given in the figure

captions in this monograph, the figures and photos can be assumed to be the work of the author. Otherwise, the photographers and references are given in the captions for their respective photos and figures.

TAXONOMIC HISTORY

The earliest known references to species currently classified in *Harrisia* include those found in Sloane (1696: 197) and Trew (1751: 3, pl. 14), both as "Cereus altissimus gracilior" presumably referring to the Jamaican endemic *H. gracilis*, and the illustrations of Plumier from around the 1690s depicting *H. divaricata* (Mottram 2002). *Harrisia gracilis* was described by Philip Miller (1768, as *Cereus gracilis*) in England from specimens received in 1728 and put into the once broadly-defined genus *Cereus* Mill. s. lat." Lamarck (1785) later described *Cactus divaricatus* (=*H. divaricata*) from Plumier's plates (Burman 1758: pl. 193) illustrating a plant from Haiti. From 1837–1905, eight more names now classified in *Harrisia* were introduced: *Cereus eriophorus* Pfeiffer 1837 (=*H. eriophora*), *Ce. bonplandii* Pfeiffer 1837 (=*H. bonplandii*), *Ce. tortuosus* Otto & Dietrich 1838 (=*H. tortuosa*), *Ce. platygonus* Salm-Dyck 1849 (=*H. adscendens*), *Ce. martinii* Labouret 1854 (=*H. martinii*), *Ce. tetracanthus* Labouret 1855 (=*H. tetracantha*), *Ce. pomanensis* Weber 1897 (=*H. pomanensis*), and *Ce. guelichii* Spegazzini 1905 (=*H. pomanensis*).

Berger (1905) noted the value of the seed characters (Fig. 4) and was the first to provide the modern sense of the genus by uniting several species from the West Indies (ser. *Harrisia*) and South America (sect. *Eriocereus* and sect. *Roseocereus*) under *Cereus* subg. *Eriocereus*. Before Berger (1905), Labouret (1853), and Schumann (1899) had delimited the West Indian and South American species in unrelated infrageneric groups under *Cereus* s. lat.

Just as botanical nomenclature was beginning to be standardized in the 1900s (Nicolson 1991), the genus *Harrisia* was erected by Britton (1908), which at the time only accommodated the West Indian species (sect. *Harrisia*). Britton (1908) described five new species and made three new combinations. The earliest published species in the genus, *Cereus gracilis* (=*H. gracilis*), was selected as the type of the genus by Britton (1908). In the same year, *Cereus adscendens* (=*H. adscendens*) from the caatinga of Brazil was described (Gürke 1908). The South American species were reclassified under the genus *Eriocereus* by Riccobono (1909). In 1910, Weingart described *Cereus regelii* (=*H. regelii*) from South America. In their monograph of the Cactaceae, Britton & Rose (1920) then proceeded to unite the South American species previously placed under *Eriocereus* (Riccobono 1909) with the West Indian species of *Harrisia*. Britton & Rose (1920) also described three new species from Florida and one species from Cuba. W.T. Marshall described *Harrisia hurstii* (=*H. divaricata* or *H. portoricensis*) in 1941 and *H. nashii* var. *straminea* (=*H. divaricata*) in 1943 from the Dominican Republic. From the extreme western end of Cuba, Areces (1980) described *H. taetra*. The arborescent *H. tetracantha* from Bolivia was combined in the genus by Hunt & Taylor (1987), whereas Britton & Rose (1920: 136) had thought this species was closer to *Trichocereus macrogonus* (Salm-Dyck) Riccob. Hooten (1991, 1992) invalidly described *Harrisia donae-antoinae* (based on a specimen of *H. aboriginum*). Franck (2012b) described *H. caymanensis* from the Cayman Islands.

The systematics of sect. *Eriocereus* of the Gran Chaco region of South America were revised by Kiesling (1996) and Leuenberger (1995, 2000a, 2000b, 2001). A detailed synopsis of the one species in eastern Brazil, *Harrisia adscendens*, was provided by Taylor and Zappi (2004). Hunt et al. (2006) recognized only 1–2 species in the West Indies similar to Schumann (1899), whereas Anderson (2001) and regional floras (Areces 1980; Correll & Correll 1982; Liogier 1994; Wunderlin & Hansen 2011; Acevedo-Rodríguez & Strong 2012) used a narrower species circumscription (Table 2). Franck (2012b) revised the genus. The evolution and biogeography of *Harrisia* was studied by Franck et al. (2013a, 2013b), resulting in the recognition of infrageneric taxa (Table 1).

The recognition of *Harrisia* as a genus has been widely adopted (e.g. Small 1933; Kreuzinger 1935; Castellanos & Lelong 1938; Moscoso 1941; Leon & Alain 1953; Correll & Correll 1982; Proctor 1984; Liogier 1994; Kiesling 1996; Wunderlin 1998) and accepted by modern treatments (Anderson 2001; Hunt et al. 2006). Contrarily, Backeberg (1938; 1977) chose to recognize three genera, *Eriocereus* (= sect. *Eriocereus*), *Harrisia* (= subg. *Harrisia*), and *Roseocereus* (= sect. *Roseocereus*) while Berger (1929) and Marshall (1941) recognized only *Eriocereus* (=subg. *Eriocereus*) and *Harrisia* (= sect. *Harrisia*). Historically, *Cereus* s. lat. had been used to refer to nearly any cactus with elongate, cylindric, columnar stems and many species of *Harrisia* were once subsumed under *Cereus* s. lat. in various treatments (e.g. Urban 1910; Vaupel 1913; Fawcett & Rendle 1926; Werdemann 1931; Moscoso 1943; Little 1945; Benson 1969; Long & Lakela 1971; Wunderlin 1982). Several genera, such as *Harrisia*, have been segregated from *Cereus*, and *Cereus* s. str. now comprises ~30 species partly characterized by its radial symmetry of stamens, relatively elongate and slender hypanthium, relatively wide flower at the opening, and few widely-spaced glabrous areoles on the hypanthium and fruit (Kiesling 1975). *Estevesia* P.J. Braun had been erroneously synonymized with *Harrisia* (Nyffeler & Eggli 2010; Hernández-Ledesma et al. 2015), but *Estevesia* is likely more related to *Cereus* s. str. and *Monvillea* Britton & Rose. Like *H. martinii* or *H. tortuosa*, *Estevesia* seems to have spinose areoles on the pericarpel and hypanthium that resemble stem areoles. A total evidence analysis suggested a monophyletic *Trichocereus* (A. Berger) Riccob. requires inclusion of *Harrisia* (Albesiano & Terrazas 2012), but this concept of *Trichocereus* appears heterogeneous and polyphyletic (Schlumpberger & Renner 2012). It has also been argued that *Echinopsis* Zucc. should be expanded to include many other genera such as *Harrisia* (Anceschi & Magli 2013; Mottram 2014). Here it is opted to retain *Harrisia* as a genus, in favor of recognizing segregate genera for the revision of *Echinopsis* s. lat. (Schlumpberger 2012; Schlumpberger & Renner 2012).

The classification of *Harrisia* within subfamilial divisions of Cactaceae has changed frequently. Britton & Rose (1920) classified *Harrisia* into a broad subtribe Cereinae (as Cereanae). This classification was modified and further split, whence *Harrisia* was allied with groups containing *Nyctocereus* (A. Berger) Britton & Rose (= *Peniocereus* (A. Berger) Britton & Rose) due to their vegetative similarities (Berger 1929; Backeberg 1934, 1938; Buxbaum 1958; Backeberg 1977). Barthlott (1988) placed *Harrisia* in the tribe Echinocereeae (= Echinocereinae), apparently based on seed morphology. The genus was also once regarded as primitive in the Cactoideae subfamily (Mauseth et al. 1998; Terrazas & Arias 2003). Molecular work placed *Harrisia* in tribe Trichocereeae (Wallace 1995; Applequist & Wallace 2002), refined to subtribe Trichocereinae by Nyffeler & Eggli (2010).

CLASSIFICATION

Harrisia lies within the Cactaceae, a monophyletic family of ca. 130 genera and 1800 species. The family is part of the order Caryophyllales as demonstrated by the presence of betalains (Wohlpart & Mabry 1968) and sieve-element plastids with peripheral protein filaments (Behnke 1976, 1993). The axillary areoles, consisting of a cluster of spines, bristles, and/or hairs, are apomorphic for the Cactaceae. Most cacti stems are succulent, leafless when mature (though, the scales of the pericarpel and hypanthium are leaves, see Mauseth 2016), do not produce leaves within the areole (apart from the leaf that subtends the areole), are covered with stomata, and exhibit delayed bark formation to maintain a photosynthetic stem, with exceptions in some species of *Leuenbergeria* Lodé, *Pereskia* Mill., and *Maihuenia* (Phil. ex F.A.C. Weber) Phil. ex K. Schum. Some species of these three genera have precocious (not delayed) bark formation, lack stomata on the stems, and have persistent leaves (Leuenberger 1986; Edwards et al. 2005). Some species of *Leuenbergeria* and *Pereskia* have half-inferior ovaries and produce functional leaves within the areoles (Leuenberger 1986; Edwards et al. 2005). The flowers in cacti are considered long-shoots, as the ovary is surrouned by stem tissue (pericarpel) (Mauseth 2006b). The cactus flower typically has numerous

intergrading scales (or leaves, see Mauseth 2016), "sepals", and "petals", as well as numerous stamens and ovules, the ovules then becoming the numerous seeds in the fruit.

With the exception of two taxa of tropical epiphytic *Rhipsalis* Gaertn. in the Old World, Cactaceae is endemic to the New World, originating ca. 35 Ma ago (Hershkovitz & Zimmer 1997; Arakaki et al. 2011), long after the Gondwanan continents South America and Africa separated from each other ca. 120 Ma ago. The succulent, photosynthetic stems of cacti are paralleled by other unrelated, cactiform species in the Old World, e.g., *Euphorbia* L., which do not exhibit areoles (Park & Jansen 2007). Cactaceae can be divided into five monophyletic subfamilies: Leuenbergerioideae, Pereskioideae, Maihuenioideae, Opuntioideae, and Cactoideae. The ribbed, columnar cacti with stem areoles subtended by a microscopic leaf (Mauseth 2007) represent subfamily Cactoideae, with approximately 1500 species in 110 genera (Nyffeler & Eggli 2010).

Cactoideae can be further divided into at least seven tribes (Korotkova et al. 2010; Nyffeler & Eggli 2010). The core Cactoideae (Hernández-Hernández et al. 2011) contains five tribes, excluding tribes Blossfeldieae and Cacteae. Blossfeldieae lacks a vascularized cortex unlike the rest of Cactoideae (Mauseth 2006a). The Cacteae seem to differ from the core Cactoideae by having flowers usually displaced from the areoles (Buxbaum 1950), often arising from between or at base of the short-shoot tubercles (or nearer to the areole in other Cacteae, e.g. *Ferocactus* Britton & Rose and *Leuchtenbergia* Hook.) and never having areoles on the flowers that resemble stem areoles. Compared to typical Cacteae, the flower shoots of core Cactoideae are shifted and arise directly from the apical portion of the areoles, similar to Opuntioideae.

The flower development (Zahra 1976) and phylogenetic position of *Calymmanthium* F. Ritter within core Cactoideae is intriguing and suggestive of two long-shoots being involved in core Cactoideae flowers. In *Calymmanthium*, a long-shoot resembling a stem elongates from the areole, apparently encasing a separate long-shoot flower bud developing within. As this stem long-shoot ceases elongating, the long-shoot flower then bursts through the stem long-shoot, and expands to expose its floral parts (e.g. stigma, anthers, "sepals," and "petals"). If this flower development in *Calymmanthium* is homologous to flower devlepment in the rest of core Cactoideae, then it may be that one stem long-shoot tissue forms the initial outer flower bud and then becomes the elongate scaly, areolate flower tube ("hypanthium") of core Cactoideae. Then, perhaps, a separate flower shoot with ovary, stamens, "sepals," and "petals" develops within the stem long-shoot. These two shoots perhaps appear mostly fused in most of core Cactoideae. This development may then allow for elongate flowers with ovaries and nectaries deeply entrenched in the pericarpel, as found in many taxa of core Cactoideae. Perhaps this hypothetical specialized development of the flower requiring one shoot encased in another shoot in core Cactoideae prevents additional flowers from proliferating from the areoles of the flowers, as is sometimes found in taxa outside of Cactoideae. This, of course, is all speculative.

Within the core Cactoideae, tribe Cereeae contains globose to columnar cacti, and includes subtribe Trichocereinae (sensu Nyffeler & Eggli 2010) with ca. 250 species in 20 genera, characterized by pilose flower areoles with acute scale tips and a pericarpel and hypanthium having numerous areoles. With the exception of *Harrisia* in the West Indies and Florida, Trichocereinae is confined to South America.

SPECIES CONCEPT

A utilitarian approach (Levin 1979; Gilmour 1989) is here employed to lend taxonomic recognition to groups of individuals that share unique morphological characters, with the supposition that morphology reflects recent common ancestry. Although sampling in previous molecular analyses (Franck et al. 2013a, 2013b) was not adequate to ascertain clear relationships among many species,

the relationships recovered were used to guide the taxonomic treatment. Additionally, since the possibility of paraphyly and polyphyly in traditional species concepts is considerable (Riesberg & Brouillet 1994), molecular monophyly should not be requisite for taxonomic recognition at or below the species level (Nixon & Wheeler 1990; Riesberg & Brouillet 1994), especially since phylogenetic context often relies on relatively few characters (e.g. DNA loci representing < 0.001% of the genome) taken from relatively few individuals. The polyphasic taxonomy approach (Colwell 1970) promoted in microorganisms (Vandamme et al. 1996; Samson & Varga 2009) is ideal for all organisms, including large eukaryotes, by analyzing several types of evidence to produce a classification with a minimum number of contradictions.

MATERIALS AND METHODS

Approximately 400 herbarium specimens (A, B, BRI, FLAS, FTG, G, GH, HAC, HAJB, HNT, IJ, JBSD, K, LPB, MAPR, MO, NCU, NY, P, PRE, PTBG, RSA, S, SI, US, USC, USF, UWI, ZSS) were examined to prepare the taxonomic treatment. Numerous historical illustrations were studied. Live plant photos (from G. Ardisson, K.A. Bradley, J.A. de Siqueira Fihlo, E.Y. Guerrero, P. Hughes, C. Hunter, B. Jestrow, R. Kiesling, D.A. Kolterman, J. Lodé, J. Menzel, J. Moore, M. Nee, L.J. Oakely, E. Oberg, Z. Rigerski, B. Ruthzats, K. Setzer, J. Tann, N. Taylor, A. Urquiola, R. Verdecia, M.A. Vincent, S. Woodmansee, J.P. Zegarra, S. Zona) in situ and ex situ with known provenance were also examined. Field studies in the Cayman Islands, Dominican Republic, Jamaica, and Florida were also conducted. Many taxa were cultivated in Lake Sarasota, Sarasota Co., Florida for further study.

MORPHOLOGY

Habit. Only one species forms large trees, the Bolivian *Harrisia tetracantha* (sect. *Roseocereus*). The Caribbean ser. *Harrisia* are generally erect shrubs though species can range from reclining shrubs to single-trunked small trees. The Brazilian *H. adscendens* (sect. *Adscendentes*) and sect. *Eriocereus* of the Gran Chaco region grow as reclining shrubs or scrambling thickets. A semi-epiphytic habit has been reported from the Pantanal of Brazil as *H. bonplandii* (Braun & Hofacker 2006), although the identity of the specimen is not consistent with *H. bonplandii*. The Cuban endemic *H. earlei* (ser. *Earlei*) grows as a decumbent, prostrate to pendent shrub.

Stems. The green photosynthetic stems of *Harrisia* are indeterminate long-shoots which contain numerous short-shoots. A cactus short-shoot is referred to as an areole, where the cluster of spines and trichomes arise (Figs. 6–7). The photosynthetic region surrounding and containing the areole is the tubercle, an undifferentiated combination of a modified leaf base and stem (Buxbaum 1950; Gibson & Nobel 1986). The term "stem" in cactus nomenclature thus may technically include leaf bases. Tubercles may be somewhat distinct on young stems but become amorphous on mature stems. The tubercles are vertically connected to form ribs. The number of ribs on a stem ranges from 3 to 14. The young stems of all species are generally erect to ascending but may begin to turn downwards due to the tenuous support of the stem. Stems of *H. adscendens* and sect. *Eriocereus* are often flexible and may become curvaceous. Stems of *H. tetracantha* are stout and rigidly erect and stems of sect. *Harrisia* are intermediate in rigidity and flexibility.

The surfaces of the photosynthetic stems are densely and evenly covered with stomata. The cuticle is fairly thin, 1–6 μm (Gibson & Horak 1978; Mauseth et al. 1998), and may be slightly rough (Gibson & Horak 1978). Under the cuticle is a thin epidermis (Mauseth et al. 1998; Arruda et al. 2005) with an outer surface that may be roughened (Mauseth et al. 1998). The epidermal cells of *H. adscendens* have straight anticlinal walls and parallelocytic stomata (Arruda et al. 2005). The collenchymatous hypodermis may be one cell thick in *H. martinii* (Gibson & Horak 1978) or 3–5 cells thick in other species (Mauseth et al. 1998; Arruda et al. 2005). Neither the epidermis nor the hypodermis contains crystals (Mauseth et al. 1998; Arruda et al. 2005). The palisade cortex (Fig. 8)

is at least 1.5 mm thick in mature stems (Mauseth et al. 1998). Both the cortex and pith may be mucilaginous (Mauseth et al. 1998). The cortex of *H. pomanensis* is reported to be non-mucilaginous with calcium oxalate dihydrate (Hartl et al. 2007) crystal aggregates concentrated in the ribs (Gibson & Horak 1978). Mucilaginous cells and an absence of amyloplasts were observed in *H. adscendens* (Arruda et al. 2005).

In addition to the central ring of vascular bundles, the pith is vascularized with medullary bundles and the cortex vascularized with cortical bundles (Mauseth et al. 1998; Fig. 8). Medullary and cortical bundles are unique to all of subfamily Cactoideae except for the basal lineage *Blossfeldia* Werderm. (Mauseth 2006a).

Harrisia produces a hard, fibrous, lignified wood (Mauseth & Plemons-Rodriguez 1998; Mauseth et al. 1998) in the inner cortex (Schwager et al. 2013) that is longitudinally interwoven (e.g. *Franck 2370*, *2896*, *2897*, *2898*, *2899*). The wood fibers are septate (Metcalfe & Chalk 1950; Mauseth et al. 1998) and libriform (Gibson 1973; Mauseth et al. 1998). Wide-band tracheids have been observed in seedlings (Mauseth 2004) but are absent in adults (Arruda et al. 2004; Mauseth 2004). Relatively long vessel elements of the xylem have been observed (Gibson 1973) with irregularly divided, multiperforate plates (Metcalfe and Chalk 1950). The wood of *H. divaricata* has been characterized as a monomorphic fibrous wood (Stevenson & Mauseth 2004). At the stem base, plants are woodiest and produce bark from the epidermis (Mauseth et al. 1998). Heartwood is not produced and cactus wood does not undergo apoptosis (Mauseth 2006b), unlike the xylem of many other woody plants. Branch-stem junctions are often constricted in subfamily Cactoideae to increase stability (Schwager et al. 2013).

It is also a stem shoot that produces the outer tissue of the pericarpel and hypanthium (flower tube) and encases the flower within. Thus, the scales of the pericarpel and hypanthium can be considered leaves that subtend an areole (Mauseth 2016).

Roots. The base of the stem grades into one to several taproots from which arise several branches to form a fibrous root system. A ±parenchymatous monomorphic to dimorphic wood has been observed in the roots of *Harrisia divaricata* (Stevenson & Mauseth 2004).

Stem areoles. The areoles of the stem are tomentose with pellucid, septate, uniseriate trichomes (Fig. 9) and contain a cluster of spines. Long, scaly trichomes may sometimes appear on stem areoles of young long-shoots (Fig. 10). The spine clusters and trichomes arise near the adaxial base of a greatly reduced leaf. The tiny, inconspicuous leaf can be seen at the abaxial base of an areole of new stem growth near the shoot apical meristem (Britton & Rose 1920; Mauseth 2007). New growth, such as spines, trichomes, or long-shoots, may continually appear from the adaxial portion of the areoles over the life of the stem. Thus, older spines and trichomes are at the base of the areoles and newer ones near the top. Long-shoots that arise from areoles may become new stems or flowers (Fig. 11). Trichomes of the stem are usually white but newly emergent trichomes can be reddish or brownish.

Spines. The spines may be modified leaves of the axillary bud (Mauseth 2006b). Mature spines are generally gray, smooth (longitudinally striate under magnification), round to somewhat flattened basally, and dilated at the base. Newly-emergent spines are more brightly colored, varying from white to yellow-green to red, with darker or blackish tips. Young spines may become straw-colored, yellowish, or blackish before turning gray. Spine clusters at each areole consist of spines of varying lengths. Longer and thicker spines are usually produced later and the older spines at the base of the areole are often thinner and shorter. The longest and thickest spines are usually found at the base of the plant.

Flowers. The flowers are long-shoots, essentially a stem containing a flower within (e.g. *Calymmanthium substerile*). As on the stem, the flowers consist of tubercles each with an areole containing a leaf as a scale. In addition to uniseriate trichomes, the areoles of the flower usually contain semi-deciduous longer, scaly trichomes (Figs. 5, 7), which are rarely present on stems (Fig. 10). The scaly trichomes may sometimes grade into spine-like forms, especially near the base of the flower. Both types of trichomes are usually white on the flower but are sometimes reddish (e.g. *Harrisia regelii*). Areoles of the pericarpel and lower hypanthium may resemble stem areoles (having spines but no scaly trichomes) on some species of sect. *Eriocereus* (e.g. *H. martinii* and *H. tortuosa*).

The pericarpel is the tissue surrounding the ovary which matures into a fruiting structure and has areoles with scales (Figs. 12–13). The term hypanthium is here used to refer to the flower tube which contains visible areoles above the pericarpel and below the sepals (Figs. 12–13). Subtending the hairy areoles of the pericarpel and hypanthium are scales which are smallest on the pericarpel and gradually increase in size along the hypanthium, eventually grading into the larger sepals (Fig. 12). The scales and sepals are both succulent. The mid-hypanthium scales exhibit significant differences among species, and here were measured at the middle third of the hypanthium (well below the sepals and well above the pericarpel), from the tip to the base where the trichomes arise. The sepals are here defined as the non-white blades occurring after the hypanthium but may intergrade with the hypanthium scales and whitish petals. The petals are white, sometimes pinkish, very thin, and membranaceous.

Flower buds (Fig. 11) are produced on the stem areoles of the distal portions of the stem. The buds first appear as scaly protrusions which then slowly engorge to become acutely globose with densely imbricate scales. The buds then elongate, forming an incipient pericarpel and hypanthium. At maturity, the pericarpel is globose and narrows into a slender hypanthium which leads to an expanding tight cluster of 20–30 sepals and petals. The petals are only initially visible the night of anthesis. The sepals reflex backwards and the petals expand outwards (Fig. 12).

The stigma is at the center of the flower, exserted beyond the anthers in mature flowers (Figs. 12–14). The arrangement of the stamens is bilaterally symmetrical with a dense array of stamens in the lower portion of the flower (the abaxial stamen cluster and lower rim stamens) and few in the upper portion (the upper rim stamens). The rim stamens are adnate to the tip of the hypanthium and held in a ring around the inner circumference of the flower. The stamens that comprise the abaxial stamen cluster (Fig. 14) arise from the middle region of the hypanthium (Figs. 13–14) and the filaments are not sheathed together (cf. *Trichocereus*-type, Schick 2011). The filaments of both stamen types may curve upwards distally. At the basal portion of the hypanthium is the beige-colored nectar chamber (Fig. 13).

Pollen. The pollen is tricolpate (to hexacolpate?), ~50–70 μm in diameter (Kurtz 1963; Leuenberger 1976) with numerous spinulae (Figs. 15–17) (Leuenberger 1976).

Chromosomes. The karyotype of *Harrisia portoricensis* from Guayanilla, Puerto Rico has been recorded as diploid, $2n = 22$ (Spencer 1955). The base haploid number of Cactaceae is 11 with polyploidy being frequent (Ross 1981). Deviations from multiples of 11 chromosomes are extremely rare in Cactaceae (Ross 1981).

Fruits. The pericarpel matures into a yellow, orange, or red fruit containing a sweet, edible, white pulp and hundreds to thousands of tiny seeds (Rojas-Sandoval & Meléndez-Ackerman 2009c; McFadyen 2012; Fig. 18). The tubercles of the fruit are often well-defined by the sulci, especially when immature (Fig. 7). A withered flower often persists on the immature fruit (Fig. 7). The withered flower, scales, and trichomes are usually deciduous on the ripened fruit. The fruit scales are retained in *Harrisia bonplandii* and *H. jusbertii*. In sect. *Harrisia* the fruits are indehiscent, whereas

in the other species the fruit splits open along lateral or apical tears, exposing the mesh of pulp and seeds (Fig. 6).

Seeds. The testa cells of the seedcoat are black, sometimes becoming reddish around the hilum-micropylar region (HMR) (Fig. 4). The testa cells are hollow and at junctures on the seed coat form pits (Gibson & Nobel 1986; Barthlott & Hunt 2000; Doweld 2001). The surface of the cells are vermiculate with striate cell junctures (Gibson & Nobel 1986; Barthlott & Hunt 2000; Doweld 2001). The top of the seed (opposite the HMR) has a curved crest of a few rows of testa cells noticeably larger (to 0.4 mm long; Fig. 4) than the rest of the seed coat (Zuccarini 1838; Barthlott & Voit 1979; Bregman 1988; Barthlott & Hunt 2000; Doweld 2001). The HMR is cavernous (Fig. 4), surrounded by the seed coat except at the bottom (Bregman 1988; Barthlott & Hunt 2000; Doweld 2001), and contains a medial sclerified band (Barthlott & Hunt 2000). The interior of the seed is composed of the embryo and endosperm (Bregman 1988). Perisperm is not evident (Bregman 1988). Each seed generally weighs ~1.5–2.0 mg (Serrano & Guzmán 1994; Alzugaray et al. 2007) and most appear to float in fresh water (pers. obs.).

Seedlings. Seedlings have a green, succulent hypocotyl to 1 cm tall, above which are two cotyledons (Zuccarini 1838; Buxbaum 1950). The cotyledons are deltoid or sometimes cleft (Ganong 1898; pers. obs.) and indistinct from the hypocotyl (Zuccarini 1838; Buxbaum 1950). The apical meristem of the epicotyl soon produces areolate tubercles (Zuccarini 1838). Ribs of seedlings are often fewer and spines more setaceous than in mature individuals. The epicotyl of *Harrisia bonplandii* reportedly first develops four ribs, then increases to eight, and finally reduces to 4–5 ribs (Ganong 1898).

ECOLOGY

Distribution and habitat. The genus ranges from the eastern Andes of Bolivia to the Gran Chaco region of south-central Argentina to the caatinga of northeast Brazil to western Puerto Rico to the Swan Islands of Honduras and up to northeast peninsular Florida (Figs. 1–3). A few species have also been naturalized in Australia (McFadyen 1986), South Africa (Henderson 2007; Shisani 2013), and Hawaii (Lorence et al. 1995). The genus is found in seasonally dry forest or shrubland. Where the species of *Harrisia* occur, the rainy season in South America is roughly Oct–Mar, and May–Oct in the West Indies and Florida. Annual precipitation is generally around 500–1200 mm. At its northern range in Florida and its southwestern range in Argentina and Bolivia, occasional freezing temperatures are experienced. Light frosts (1–2 per year) experienced by species in cultivation in Lake Sarasota, Florida, seemed well-tolerated and not detrimental. The highest elevation is experienced by *H. tetracantha* at ca. 2600 m (*Cárdenas 5021*), while some populations in the Caribbean region are near sea level and only a few meters inland from the high tide line (e.g. *H. fragrans*, *Franck 473, 1236*).

Phenology. From the initial appearance of the flower buds, several weeks pass until anthesis occurs. Flower bud production and efflorescence seem to be dependent on temperature and rainfall. Flower bud formation in *Harrisia portoricensis* was strongly correlated with monthly mean temperature and monthly minimum temperature while efflorescence was strongly correlated with rainfall (Rojas-Sandoval & Meléndez-Ackerman 2011a). Efflorescence of *H. fragrans* was observed to have two peaks, in May and October (Rae 1995) coinciding with the beginning and end of the rainy season. Plants of *H. fragrans* in the shade rarely flowered but invested more energy in stem growth (Rae 1995), perhaps to gain access to sunnier locations. Efflorescence seems to peak after heavy rain in *H. adscendens* (Lima 2007) and in *H. tetracantha* (M. Mendoza & M. Nee, pers. comm.).

Pollination. The flowers are nocturnal and open only once, opening after sunset and remaining open until near sunrise. Kaiser and Tollsten (1995) characterized *Harrisia adscendens* as moth-pollinated due to its nocturnal anthesis and distinctly pleasant odors. Scogin (1985) identified

H. pomanensis as having a hawkmoth-pollinated syndrome as its nectar is low in energy. The flowers of *Harrisia* may also be chiropteriphilous due to the presence of clustered stamens and hexose sugars, characters amenable to pollination by the New World glossophagine bats (Fleming et al. 2009). Pollen from *Harrisia* has been reported in the stomach contents of two species of bats in Cuba (Silva Taboada 1979). Several different insects have been observed visiting flowers, including hawkmoths (Sphingidae) (*H. portoricensis*, Rojas-Sandoval & Meléndez-Ackerman 2011a), sap-feeding beetles (Nitidulidae) (*H. fragrans*, Dobson 1972; pers. obs.), long-horned beetles (Cerambycidae) (*H. fragrans*, Hutchinson & Pazara 2004), scarab beetles (Scarabaeidae) (*H. pomanensis*, *Nee 51239*), and stingless bees (Meliponidae) (*H. pomanensis*, Allier et al. 2010). Flowers appear to be self-compatible (Rojas-Sandoval & Meléndez-Ackerman 2009c; pers. obs.) and self-pollination may be assisted by the wind (Rojas-Sandoval & Meléndez-Ackerman 2011b; Rojas-Sandoval 2012).

Fruit set and consumption. Fruits take several weeks to mature, up to ~60 days after efflorescence (Rojas-Sandoval & Meléndez-Ackerman 2009c; pers. obs.) and to another ~30 days to dehisce and split open in South American species (pers. obs.). Splitting may depend on precipitation. Mature fruits can remain on the plant for months (Rae 1995; pers. obs.).

The internal pulp of the fruits of *Harrisia* is sweet, fleshy, and likely palatable to a variety of animals such as humans (pers. obs.; Fig. 18), birds (Rae 1995; Rojas-Sandoval & Meléndez-Ackerman 2009a), mice (Rojas-Sandoval & Meléndez-Ackerman 2009a), lizards (Rojas-Sandoval & Meléndez-Ackerman 2009a), crab-eating foxes (Bianchi 2009; Bianchi et al. 2013), brown-nosed coatis (Bianchi 2009; Bianchi et al. 2013), crabs (Areces-Mallea 2003), goats (Meléndez-Ackerman et al. 2008), and social wasps (Santos et al. 2007). The fruits are thought to be an important part of the diet of brown-nosed coatis in the wet season (Bianchi et al. 2013). The fruit rind is usually not consumed as it is essentially stem tissue. Seed dispersal of *Harrisia* has likely been assisted by birds (ornithochorous) and/or bats (chiropterochorous) as many populations are limited to isolated islands (i.e., West Indies). Species of the bat subtribe Stenodermatina (Chiroptera) are frugivores with distributions in South America, Central America, and the Caribbean (Dávalos 2007) and may potentially consume *Harrisia* fruits. Seed dispersal by water may also be possible (Bregman 1988).

Germination and growth. Seeds of *Harrisia* do not appear to experience much dormancy (~8 weeks, Rojas-Sandoval & Meléndez-Ackerman 2009c), as they sometimes germinate in the fruit (vivipary), e.g. in *H. eriophora* (Barrios et al. 2012), *H. fragrans* (Fig. 19), and *H. martinii* (Cota-Sánchez 2004). Vivipary may depend on the hydration of the plants (R. Kiesling, pers. comm.). Gibberellic acid and scarification by sulfuric acid have been used to increase germination (Dehgan & Pérez 2005) as well as soaking the seeds in water (L. Boehner, pers. comm. 2011). Seeds of *H. martinii* experienced maximum germination three days after sowing washed seeds (Alzugaray et al. 2007). Seeds of *H. fragrans* are viable for at least one year (pers. obs.) to 19 months (Bradley & Hines 2007). Seeds from cross-pollinated flowers were larger and germinated better than those from self-pollination in *H. portoricensis* (Rojas-Sandoval & Meléndez-Ackerman 2009c). Seeds germinate by a fissure between the HMR and upper seed coat like an operculum (Bregman & Bouman 1983). Possible functions of the cavernous HMR might be to assist in uptake and retention of water for germination or conversely to maintain an air pocket (for floating or oxygen requirements?), but neither has been studied. It could be speculated that the function of the large hollow apical testa cells is to assist in floating (R. Kiesling, pers. comm.).

Mycorrhizal arbuscles and vesicles were reported to be absent from the roots of *Harrisia fragrans* (Fisher & Jayachandran 2005), which is possibly common among cacti (Muller et al. 1994; Bashan et al. 2000). Seedlings of many cactus species benefit from nurse plants (Godínez-Álvarez et al. 2003) and nurse plant association has been implicated in species of series *Harrisia* (Rae 1995; Rojas-Sandoval & Meléndez-Ackerman 2009b; Moore 2011), with most seedlings of *H. fragrans*

appearing in shade (Bradley & Hines 2007). Invasive plants have been correlated with negatively affecting the demography of *H. portoricensis* (Rojas-Sandoval 2007; Guerrero et al. 2011; Rojas-Sandoval & Meléndez-Ackerman 2012).

Vegetative reproduction is frequent when stems break and detach from the parent plant. The stems can proceed to produce roots along tissue nearest to the ground and produce a new plant. The ribs of the stem may contract during water stress. The stems (and likely the stem tissue of the flowers) function as the photosynthetic region of the plant, utilizing crassulacean acid metabolism or CAM photosynthesis, as documented in all cacti so far (Nobel 2002; Hernández-González & Villarreal 2007), with possible exceptions in *Leuenbergeria* and *Pereskia* (Rayder & Ting 1981; Edwards et al. 2005).

Herbivory. Various insects predate on the stems such as armored scale insects (Diaspididae) (Claps & de Haro 2001; pers. obs.), weevils (O'Brien 1976; McFadyen 1979a), long-horned beetles (McFadyen & Fidalgo 1976), moth larvae (McFadyen 1980), cochineal insects (Claps de Haro 2001), midges (McFadyen 2012), fly larvae (McFadyen 2012), mealybugs (McFadyen 1979b; Claps de Haro 2001), and possibly some cockroaches (*Eurycotis floridana* Walker). The mealybug *Hypogeococcus* (see Aguirre et al. 2016) has been successfully used to control invasive species of sect. *Eriocereus* in Australia (McFadyen 1986) and South Africa (Klein 1999), especially *H. martinii*. The invasive *Cactoblastis cactorum* Berg avoids *Harrisia* (Tate et al. 2009). Myxomycetes have been observed on decaying *Harrisia* (Eliasson 2004). Moth larvae (Pyralidae) consume developing fruits (McFadyen 2012; Fig. 19). One of the principal dry season foods of the Chacoan peccary may be the stems of *Harrisia* (Mayer & Brandt 1982). Exotic rhesus macaques have been observed feeding on stems of *H. portoricensis* (Brecken 2000). Introduced iguanas are reported to eat the flowers of *H. aboriginum* (Bradley et al. 2004) and gopher tortoises have been reported eating stem bases of *H. aboriginum* (Woodmansee et al. 2007). Introduced feral hogs were responsible for the death of at least one plant of *H. fragrans* (Bradley & Hines 2007).

ETHNOBOTANY

The internal flesh of the fruits of *Harrisia* are edible and used locally by humans (Fawcett & Rendle 1926; Morton 1962; Barton et al. 1990; Schmeda-Hirschmann 1994; Andrade 2002; Arenas and Scarpa 2007; Fig. 18), although they should be avoided if already visited by other animals because of the possibility of disease transmission (Martínez 2010). The flowers of *H. bonplandii* are sometimes boiled by the Ayoreo of Paraguay (*Schmeda 1185* & *1489*, Schmeda-Hirschmann 1994) and the Chorote of Argentina (*Scarpa 562*, Arenas and Scarpa 2007). The boiled or roasted roots of sect. *Eriocereus* are sometimes eaten (Scarpa & Arenas 2002). Decoctions of the roots of *H. adscendens* are used medicinally (Andrade et al. 2006; Agra et al. 2007; Rocha & Agra 2011). *Harrisia pomanensis* has been used for forage (Palacio et al. 2011). Use of the flowers and stems of *Harrisia* in homeopathy has been reported (Waizel-Bucay 2009). The dried woody stem of *H. gracilis* was said to be used as a torch, which baited fish for harpooning when held out from the canoe (Edwards & Lindley 1818; Fawcett & Rendle 1926). Descourtilz (1821: 281–284) described its use as a torch and the cautious use of the juice of the stem of *H. divaricata* in vinegar or castor oil topically as a depilatory and against toothache, warts, and ringworm fungi. Slats for mango crates were said to be sometimes made from *H. divaricata* (Curtis 1947).

CHEMISTRY

The *n*-alkane content of the cuticular wax was relatively high in *Harrisia tetracantha*, composed of a fairly even distribution of C_{18}–C_{34} and C_{36} *n*-alkanes (Maffei et al. 1997). The *n*-alkane content of *H. martinii* has been reported as dominant in C_{37} with significant fractions of C_{33}, C_{35}, and C_{39} (Herbin & Robins 1968). Presumably, the wax is biosynthesized from fatty acids and is partly responsible for the low epidermal absorbance of water (Barthlott & Capesius 1974). Alkaloids

have been reported from species of *Harrisia* in Cuba (Martínez 1995), possibly similar to the phenylpropanoid alkaloids tyramine and hordenine which are common in the related genus *Echinopsis* s. lat. as well as other species of subfamily Cactoideae (Agurell 1969; Agurell et al. 1971). The toxicity of *Harrisia* was rated as relatively low (Levin & York 1978). The sap of *H. gracilis* is very dilute, in accord with other succulents (Harris & Lawrence 1917).

Monoterpenes (geraniol, geranial, and neral) and a phenylpropanoid (methyl benzoate) have been identified from the flowers of *Harrisia adscendens* (Kaiser & Tollsten 1995). Scogin (1985) found the flowers of *H. pomanensis* to have hexose as the dominant nectar sugar.

Betacyanin pigments (tetrahydropyridine-dihydroindole glycosides) have been characterized in the fruit of *Harrisia bonplandii*, with the total betacyanin content being 41% phyllocactin, 23% betanin, 18% isobetanin, and 18% isophyllocactin (Piattelli & Imperato 1969, as *H. guelichii*). Seeds of *H. pomanensis* are composed of ~11% protein, ~8% water ~2% ash, and a relatively low oil content (~15%) (Serrano & Guzmán 1994). The majority of the oil is 18:2 (62%) with significant amounts of 18:1 (21%) and 16:0 (13%) (Serrano & Guzmán 1994). The highest mineral content was, in descending order, potassium, magnesium, calcium, and sodium (Serrano & Guzmán 1994). Polyacrylamide gel electrophoresis of seed protein patterns of *H. pomanensis* have been compared to other cacti (Carreras et al. 1997). Caffeine has been reported in the seeds of *H. adscendens* (Friese 1935; see also Christenhusz 2008), though this is considered doubtful until corroborated.

PHYLOGENY

The monophyly of *Harrisia* and its infrageneric classifications are supported by molecular phylogenies and morphology (Schlumpberger & Renner 2012; Franck et al. 2013a). The generic relationships of *Harrisia* within subtribe Trichocereinae show a sister-group relationship with *Leucostele* Backeb. based solely on plastid data (Schlumpberger & Renner 2012; Franck et al. 2013a), while data from nuclear loci do not yet corroborate this relationship (Franck et al. 2013a). Species within sect. *Eriocereus* are very closely related (Franck et al. 2013a) and the same is true for the species of sect. *Harrisia* (Franck et al. 2013a, 2013b). Interspecies relationships in these two sections are difficult to assess and probably represent recent radiations (Franck et al. 2013a).

The monotypic ser. *Earlei* is supported as basal in sect. *Harrisia* (Franck et al. 2013a, 2013b). Within ser. *Harrisia*, three main groups emerge from molecular analyses (Franck et al. 2013b). The "Cuba group" comprises all the Cuban species of ser. *Harrisia* (*H. eriophora*, *H. fernowii*, *H. taetra*). The "Florida group" consists of both Florida species (*H. aboriginum* and *H. fragrans*). The "SEGAB group" contains all non-Cuban and non-Florida species (*H. brookii*, *H. caymanensis*, *H. divaricata*, *H. gracilis*, *H. portoricensis*). The "SEGAB group" may also contain or be most related to *H. fernowii* from southeast Cuba (Franck et al. 2013b), having relatively small seeds and flowers that are predominantly greenish.. Morphology suggests the Florida group is most closely related to *H. eriophora* and *H. taetra* from west Cuba, which all share fairly large seeds and flowers with reddish coloration (Franck et al. 2013b).

CHARACTER EVOLUTION

The best-defined apomorphy for *Harrisia* is the cavernous hilum-micropylar region of the seed (Fig. 4). The scaly trichomes of the flower (Fig. 5) also appear apomorphic in *Harrisia*, though it is speculative without having adequate knowledge of flower trichomes in the rest of Trichocereinae (e.g., *Leucostele*). Characters of the Bolivian *H. tetracantha* such as its many-ribbed, thick, erect stems may be plesiomorphic as these stems are common in subtribe Trichocereinae. Slender stems, few ribs, and flexible stems may then be apomorphic or homoplasious, being quite rare in subtribe Trichocereinae. If *Harrisia* is sister to the arborescent *Leucostele*, as suggested by the plastid data

(Schlumpberger & Renner 2012; Franck et al. 2013a), then arborescence may be a plesiomorphic feature in *H. tetracantha*.

Reduction in rib number may have occurred twice, with sect. *Eriocereus* and ser. *Earlei*. Splitting or dehiscing fruits are likely plesiomorphic, as they are present in three sections of *Harrisia* and absent in sect. *Harrisia*. Stigma lobes are relatively long, plesiomorphic in three sections of *Harrisia*, and reduced in sect. *Harrisia*. Yellow fruits are apomorphic, rare in sect. *Adscendens* and common in sect. *Harrisia*. The reappearance of red fruits in two Florida species in ser. *Harrisia* is possibly a reversion to the ancestral red fruits or homoplasious. Seeds are relatively large in sect. *Adscendens*, ser. *Earlei*, the west Cuban species, and the Florida species. The smaller seeds in some species of ser. *Harrisia* appear to be derived. The flower scales in subg. *Eriocereus*, sect. *Adscendens*, and ser. *Earlei* are usually reddish and the green to yellow-green scales in some species of ser. *Harrisia* are probably derived. Except for *H. bonplandii*, *H. jusbertii* and perhaps *H. regelii*, all species have ribs distinctly separated by a line at the sulcus.

BIOGEOGRAPHY

Diversification. Because of the high diversity and endemism of Cactaceae in the central Andes, sympatric with *Harrisia tetracantha*, the genus is presumed to have originated in the central Andes (Wallace 1997; Franck et al. 2013a). Its dispersal into Brazil from the central Andes would then match the distribution patterns of many other cacti (Franck et al. 2013a). Its diversification in the Gran Chaco (sect. *Eriocereus*) and in the West Indies and Florida is presumed a recent event in the Pleistocene (Franck et al. 2013a). Sect. *Harrisia* is disjunct from the Brazilian sect. *Adscendentes*. The colonization of the West Indies probably occurred by dispersal from Brazil to west Cuba (Franck et al. 2013a).

Range. Most species of *Harrisia* are narrow endemics, except for sect. *Eriocereus* of the Gran Chaco and *H. adscendens*, which have larger ranges. Given the narrow range of many species, it is likely that the distribution of *Harrisia* has repeatedly expanded and shrunk in response to climatic alterations of arid habitat. The climate was cooler and more arid 0.7–1.2 Ma ago (Clark et al. 2006), near the estimated dispersal of *Harrisia* into the Gran Chaco and West Indies (Franck et al. 2013a). Numerous cycles of increasing and decreasing aridity throughout the Pleistocene (Johnson 1982) are indicated by various regional studies from South America (van der Hammen 1974; Leyden 1985; Oliveira et al. 1999; Strecker et al. 2007; Werneck et al. 2011), nuclear Central America (Leyden 1984; Leyden et al. 1994), Jamaica (Street-Perrott et al. 1993), Haiti (Hodell et al. 1991), and Florida (Watts 1975; Grimm et al. 1993).

OFT-CONFUSED TAXA

Several genera of cacti are often misidentified as *Harrisia*. Besides seed and flower trichome morphology, the easiest characters to discern *Harrisia* are the presence of the abaxial stamen cluster, pilose areoles that are moderately densely arranged on the hypanthium and fruit, a tuberculate immature fruit, and the lack of aerial roots. Below is a list of commonly confused genera of cacti and examples of characters which differentiate them from *Harrisia*.

Acanthocereus (Engelm. ex A. Berger) Britton & Rose, stamens arranged radially symmetrical.
Cereus Mill., hypanthium areoles without conspicuous hairs, hypanthium and fruit with sparsely arranged areoles.
Hylocereus (A. Berger) Britton & Rose, stems with aerial roots.
Leptocereus (A. Berger) Britton & Rose, stamens arranged radially symmetrical
Monvillea Britton & Rose (=*Praecereus* Buxb.), hypanthium areoles without conspicuous hairs, hypanthium and fruit with sparsely arranged areoles.

Peniocereus (A. Berger) Britton & Rose, (=*Nyctocereus* (A. Berger) Britton & Rose), stamens arranged radially symmetrical.
Selenicereus (A. Berger) Britton & Rose, stems with aerial roots.
Stenocereus (A. Berger) Riccob., e.g. misidentified as *Harrisia* in Christenhusz (2008), stamens arranged radially symmetrical.

HERBARIUM SPECIMEN RECOMMENDATIONS

Well-made herbarium specimens greatly enhance the study of *Harrisia*, though spiny and bulky succulents like *Harrisia* are often neglected by herbarium personnel in the field. To make herbarium specimens of *Harrisia*, it is ideal to have mature flowers, fruits, a cutting of the apical stem, and whole areoles with spines from the base of the plant.

Healthy, vigorous shoots are often most diagnostic for exemplifying stem morphology. Length-wise sections of the stem help to retain their shape by decreasing rib contraction during pressed drying. A cross-section of the stem enables the easiest determination of rib number. Areoles from basal portions of the stems or trunk should be collected as they are diagnostic and often contain the longest and thickest spines. Stems, flowers, and fruits should be cut length-wise so that both sides can be viewed. The exterior of the stem, flower, and fruit is most informative for species identification. Some pollen can be packeted before mounting and the stigma can be protruded from the flower. The flower petals and pollen are extremely susceptible to insect damage, e.g. by book lice (*Liposcelis* Motschulsky) (Retief et al. 1995). To attempt to retain fruit dimensions and shape, seeds and pulp should be removed from a halved fruit. Color photographs can be included with the specimen, as they are informative of plant habit, shape, and color, all of which are easily lost from herbarium specimens.

TAXONOMY

Journal abbreviations follow Bridson et al. (2004), book abbreviations follow Stafleu et al. (1976–1988), author abbreviations follow Brummitt & Powell (1992), and herbarium acronyms follow Thiers (2016).

HARRISIA Britton, Bull. Torrey Bot. Club 35: 561. 1908. *Cereus* [unranked as "Gruppe"] *Eriophori* Vaupel in Engler, Nat. Pflanzenfam. ed. 2: 637–638. 1925 [fide Mottram 2014]. *Harrisiae* Buxb. [unranked as "linea"], Madroño 14: 182. 1958. **TYPE**: *Harrisia gracilis* (Mill.) Britton.

Columnar, succulent shrubs or trees. Bark smooth to slightly flaking. Stems green to glaucous-green, pendent, prostrate, decumbent, arching, reclining, clambering, ascending, or erect, occasionally falling over and rerooting, with 3–14 ribs; elongate, indeterminate, basally becoming woody. Stem sulci usually defined by a sinuous line, occasionally absent. Spines 3–20 on stem areoles, smooth, straw-colored to gray, microscopically striate longitudinally, subulate, round to somewhat flattened basally, to 8 cm long and 1.8 mm thick, fewest on distal areoles and becoming more numerous on basal areoles of stems. Young spines white to yellow to red to nearly black with darker tips. Stem areoles tomentose with short septate, uniseriate trichomes to 1.5 mm long. Tiny leaves evident on tips of vigorous shoot apical meristems, deltoid, 0.5–1.1 mm long. Flower buds globose, ovoid, or obovoid, usually hairy with scaly trichomes. Flowers lateral and distal on stems, 14–26 cm long and 8.5–16.5 cm wide, nocturnal, open only once. Pericarpel and hypanthium areoles villous to pilose with scaly trichomes, 2.5–12 mm long, sparse to copious, persistent to deciduous; trichomes sometimes grading into spines. Pericarpel green to purplish red, with deltoid to lanceolate scales, green to brown to red. Hypanthium green to brown to red, scales green to brown to red, rounded-truncate and somewhat erect basally, deltoid to lanceolate, acute to subulate at the tip. Sepals green to brownish to reddish, linear, acute. Petals white, rarely pinkish, ovate with slender

limb, apiculate, margins roughened-entire to irregularly denticulate. Stamens adnate to inner hypanthium, filaments straight or often upcurved, arrangement bilaterally symmetrical, ca. 100 stamens concentrated in the lower region of the flower, ca. 50 sparsely arranged in upper ring. Filaments basally light green to white distally. Anthers beige. Pollen spherical, tricolpate (to hexacolpate?), covered with numerous spinulae, sulci very shallow. Pistil exserted beyond to sometimes level with the anthers, style light green to white, stigma 10–15 lobed, fimbriate. Fruits yellow to red, 3.5–8 x 3.5–8 cm, depressed globose to spherical to ellipsoidal, with hundreds to thousands of seeds, pulp white and sweet. Seeds black, oblong rectangular to squarish to clam-shaped, 1.3–2.4 x 1.8–3.35 mm (measured near the middle of their dimensions), hilum-micropylar region cavernous, apical margin testa cells enlarged.

Distribution. One species is restricted to the inter-Andean valleys of southeast Bolivia, five species occur in the Gran Chaco region of South America (Argentina, Bolivia, Brazil, Paraguay, and Uruguay), one species is found in the caatinga of northeast Brazil, and 11 species occur in the West Indies (Greater Antilles, Bahamas, southern coastal Florida) (Figs. 2–4); also naturalized in Australia, South Africa, and Hawaii; one species is known only from cultivation. 0–2600 m.

Etymology. For William Harris (1860–1920), of Scottish descent, resident botanist of Jamaica 1881–1920 (Johnson 1921).

Discussion. *Harrisia* is characterized by seeds with a cavernous hilum-micropylar region and enlarged apical testa cells (Fig. 4), scaly long trichomes (2.5–12 mm long) on the reproductive areoles (Fig. 5), large nocturnal flowers (14–26 cm long) with a cluster of stamens in the lower (abaxial) portion (Figs. 12–14), yellow to red fruits with hundreds of seeds and a sweet pulp (Fig. 18), and stems that do not put out adventitious roots (unless the stems are fragmenting and/or in contact with the ground). *Harrisia* is here divided into two subgenera, four sections, and two series. The main purpose in establishing these infrageneric taxa is to emphasize two speciose groups: the 6 shrubby to clambering species native to the Gran Chaco region (sect. *Eriocereus*) and the 10 shrubby species native to the West Indies (ser. *Harrisia*). In the original publication of *Harrisia* (Britton 1908), *H. gracilis* was explicitly cited as the type of the genus (Britton 1908: 563), contrary to the later typification cited by Mottram (2014).

Key to species of *Harrisia*

1. Seed length and width subequal, differing by < 0.5 mm, semi-lustrous (subg. *Eriocereus*).

2. Trees, with a well-developed central trunk; stems mostly stiffly erect; ribs 7–9; fruits narrowly apically dehiscent (sect. *Roseocereus*); Bolivia ..... **1. Harrisia tetracantha**

2. Shrubs, trunk poorly developed or absent; stems erect, curvaceous, arching, scrambling, clambering, or prostrate; ribs 3–8; fruits widely & laterally dehiscent (sect. *Eriocereus*).

3. All spines of mature stems short, to 5 mm long; known from cultivation only ..... **3. Harrisia jusbertii**

3. One to several spines of mature stems long, to 2–5 cm long.

4. Most areoles with the radial spines appearing greatly reduced in length compared to the central spine(s), with the 1–4 central spines 1.5–2 times as long as most radials spines; ribs mostly 3–5, often strongly undulate with areoles on pronounced tubercles.

5. Pericarpel and lower hypanthium areoles unlike stem areoles, with reddish scaly hairs and without spines; mid-hypanthium scales 7.9–11.5 mm long; fruit without spines (spines rare on flower or fruit); Argentina ..... **6. Harrisia regelii**

5. Pericarpel and lower hypanthium areoles resembling stem areoles, often with spines, tufts of uniseriate trichomes, and without scaly hairs; scaly hairs white; mid-hypanthium scales 2.7–4.9 mm long; fruit usually with spines; Argentina, Paraguay ..... **4. Harrisia martinii**

4. Most areoles with spines of relatively similar length, with the central spines less than 1.5–2 times as long as most radial spines; ribs 3–7, shallowly undulate with areoles on slightly pronounced tubercles.

6. Sulcus undefined, no line between ribs; ribs 3–5, often sharply angular; scales of mature fruit persistent and concolorous; Argentina, Bolivia, Brazil, Paraguay ..... **2. Harrisia bonplandii**

6. Sulcus evident as line between ribs; ribs 4–8, often rounded; scales of mature fruit usually withering-deciduous and discolorous, occasionally persistent and red.

7. Ribs 4–6; pericarpel areoles without spines, unlike stem areoles; mid-hypanthium scales 13.6–18.3 mm long; fruit not spiny; Argentina, Bolivia, Paraguay ..... **5. Harrisia pomanensis**

7. Ribs 6–8; pericarpel areoles resembling stem areoles, often with spines and tufts of uniseriate trichomes; mid-hypanthium scales 5.7–7.6 mm long; fruit often spiny; Argentina, Paraguay, Uruguay ..... **7. Harrisia tortuosa**

1. Seeds oblong, > 0.5 mm longer than wide, lustrous (subg. *Harrisia*).

8. Stigma lobes 1.2–2 cm long; fruits dehiscent; stem glaucous-green to green (sect. *Adscendentes*); Brazil ..... **8. Harrisia adscendens**

8. Stigma lobes 0.3–1.0 cm long; fruits indehiscent; stem green (sect. *Harrisia*).

9. Ribs 5–7; newly emergent spines bright red to dark red; decumbent, prostrate to pendent shrub (series *Earlei*); Cuba ..... **9. Harrisia earlei**

9. Ribs 8–14; newly emergent spines white to yellow to brown, any reddish coloration faint; erect to reclining shrub (series *Harrisia*).

10. Spines similar on distal and basal areoles of stem (spines rarely longer and thicker on basal trunk areoles of *Harrisia gracilis*), spines of basal areoles not overlapping spines of adjacent areoles; longest spines < 3.5 cm long; fruit globose.

11. Pericarpel, hypanthium, and scales green to yellow-brown, without pink or red; mid-hypanthium scales 11.6–12.8 mm long; seeds 1.3–1.6 × 2.1–2.3 mm; Jamaica ..... **17. Harrisia gracilis**

11. Pericarpel, hypanthium, and/or scales with pink or red; mid-hypanthium scales 4.5–10.3 mm long; seeds 1.7–2.0 × 2.7–3.0 mm.

12. Scales 7.0–10.3 mm long at mid-hypanthium; pericarpel and immature fruit purple to reddish green; mature fruit orange to red, rarely yellow; spines to 3.5 cm long; Florida ..... **16. Harrisia fragrans**

12. Scales 4.5–8.0 mm long at mid-hypanthium; pericarpel and immature fruit green; mature fruit yellow (immature fruit sometimes orange); spines to 1.5 cm long; Florida ..... **10. Harrisia aboriginum**

10. On basal areoles of stem, spines longer and thicker, usually spreading and ..overlapping spines of adjacent areoles; longest spines 3–12 cm long; fruit globose to ellipsoidal.

13. Longest spines (usually on basal areoles) 3–3.5 cm; mature fruit oblong, ellipsoidal; seeds 1.55–1.7 × 2.65–2.85 mm; Bahamas ..... **11. Harrisia brookii**
13. Longest spines (usually on basal areoles) > 5 cm; mature fruit globose to ovate (rarely ellipsoidal); seeds 1.4–2.2 × 2.0–3.35 mm.

14. Most seeds 1.7–2.2 × 2.6–3.35 mm; sepals or upper scales purplish to reddish; mid-hypanthium scales 5.4–8.7 mm long.

15. Stem nearly inaccessible, spines densely crowded and overlapping;hypanthium and lower scales purplish to reddish; Cuba ..... **19. Harrisia taetra**
15. Stem accessible, spines fairly sparse or moderately overlapping; hypanthium and lower scales green; Cuba ..... **14. Harrisia eriophora**

14. Most seeds 1.4–1.7 × 2.0–2.8 mm; sepals and upper scales green to yellow-green to brown-green; mid-hypanthium scales 8.5–15.0 mm long.

16. Flowers to 15 cm long; mid-hypanthium scales 8.5–10.0 mm long; longest spines (usually on basal areoles) 0.7 mm thick; Cayman Islands, Swan Islands(?) ..... **12. Harrisia caymanensis**
16. Flowers 16.5–21 cm long; mid-hypanthium scales 8.6–15.0 mm long; longest spines (usually on basal areoles) 1.0–1.2 mm thick.

17. Hypanthium scales ovate to ovate-lanceolate, faintly arched at base; immature fruit without well-defined sulci, moderately tuberculate; Cuba ..... **15. Harrisia fernowii**
17. Hypanthium scales ovate-lanceolate, strongly arched at base; immature fruit strongly tuberculate with well-defined sulci.

18. Spines fairly sparse or moderately overlapping, stem accessible; mid-hypanthium scales 11–13.1 mm long; Hispaniola ..... **13. Harrisia divaricata**
18. Spines densely crowded and overlapping, stem nearly inaccessible due to spines; mid-hypanthium scales 8.6–9.8 mm long; Hispaniola(?), Puerto Rico ..... **18. Harrisia portoricensis**

I. HARRISIA subg. ERIOCEREUS (A. Berger) A.R. Franck, Syst. Bot. 38: 218. 2013. *Cereus* Mill. [unranked as "Reihe"] *Tortuosi* K. Schum., Gesamtbeschr. Kakt. 54, 135. 1899. *Cereus* Mill. subg. *Eriocereus* A. Berger, Rep. (Ann.) Missouri Bot. Gard. 16: 74. 1905. *Eriocereus* (A. Berger) Riccob., Boll. Reale Orto Bot. Palermo 8: 238. 1909. *Harrisia* Britton [unranked] *Eriocereus* (A. Berger) Britton & Rose. Cact. 2: 148. 1920. **TYPE**: *Harrisia tortuosa* (J. Forbes ex Otto & A. Dietr.) Britton & Rose.

Shrubs or large trees. Stems arching, reclining, clambering, ascending, or erect, 3–9 ribs. Spines to 4.6 cm long and 1.7 mm thick. Newly emergent spines yellow-green to red. Seed length and width subequal, 1.7–2.2 × 1.8–2.5 mm.

One species in the Eastern Cordillera of Bolivia and five species in the Gran Chaco region of southeast Bolivia, north Argentina, Paraguay, southwest Brazil, and west Uruguay (Fig. 1), and naturalized in Australia, South Africa, and Hawaii; scrub forest and scrubland; 50–2600 m.

This subgenus is defined by its seeds having a nearly equal length and width. Berger (1905) unambiguously designated the type of *Cereus* subg. *Eriocereus*, though Hunt et al. (2006) referred to Backeberg (1960) as typifying the name. Although Britton & Rose (1920) included a partitioned group *Eriocereus* under *Harrisia*, they did not clarify any rank (as they had done for infrageneric names of other genera like *Cereus* and *Opuntia*) and are not considered to have made the subgeneric combination for *H.* subg. *Eriocereus*.

Ia. HARRISIA sect. ROSEOCEREUS (Backeb.) A.R. Franck, Syst. Bot. 38: 218. 2013. *Roseocereus* Backeb., Blätt. Kakteenf. 1938–6. 1938. **TYPE**: *Harrisia tetracantha* (Labour.) D.R. Hunt.

1. Harrisia tetracantha (Labour.) D.R. Hunt, Bradleya 5: 92. 1987. *Cereus tetracanthus* Labour., Rev. Hort. (Paris) 4: 25. 1855. *Eriocereus tetracanthus* (Labour.) Riccob., Boll. Reale Orto Bot. Palermo 8: 244. 1909. *Trichocereus tetracanthus* (Labour.) Borg, Cacti: a gardener's handbook for their identification and cultivation 137. 1937. *Roseocereus tetracanthus* (Labour.) Backeb., Jahrbücher der Deutschen Kakteen-Gesellschaft, 30. 1942. *Echinopsis tetracanthus* (Labour.) Anceshi & Magli, cactusinhabitat 40. 2013. **NEOTYPE** (Franck 2012b): **Bolivia**. Santa Cruz Dept., [Manuel María] Caballero Prov., NE of Abra de Quiñe, shrubland, upper limit of arid woodlands, 31 Dec 1995, *Nee 46674* (NY; isoneotypes: LPB, MO, USZ).

Cereus tetracanthus var. *boliviana* F.A.C. Weber ex K. Schum., Gesamtbeschr. Kakt. 81. 1899. *Cereus bolivianus* (F. A. C. Weber ex K. Schum.) F. A. C. Weber ex K. Schum., Monatsschr. Kakteenk. 12: 21. 1902. *Eriocereus tetracanthus* (Labour.) Riccob. var. *bolivianus* (F. A. C. Weber ex K. Schum.) Backeb., Kaktus-ABC 179. 1936. *Trichocereus tetracanthus* (Lab.) Borg var. *boliviensis* (F. A. C. Weber ex K. Schum.) Borg, Cacti: a gardener's handbook for their identification and cultivation 137. 1937. **TYPE**: **Bolivia**. [Cochabamba Dept.], Cochabamba.

Tree to 6 m. Stems erect, ribs 7–9. Upper stems 3–5 cm wide, lower woody stems to 15 cm wide, basal trunk to 30 cm wide. Flowers 17–21 cm long. Pericarpel green. Hypanthium green. Mid-hypanthium scales 3.8–5.3 × 7.8–10.3 mm. Scales deltoid to deltoid-ovate, red to reddish green apically, green basally. Sepals brownish green. Fruit tearing apically. Figs. 4, 20–22.

Distribution. Eastern Cordillera of the Andes, Bolivia (Fig. 1); seasonally dry scrub forest of inter-Andean valleys; 1200–2600 m.

Specimens examined. **BOLIVIA**: COCHABAMBA DEPT.: San Pedro [Tarata?], *Cárdenas 5021* (US); Esteban Arce Prov., Tiataco, *Kamm s.n.* (USF). SANTA CRUZ DEPT.: Florida Prov.: Pampa Grande, *Nee & Vargas C. 44709* (MO, NY); Pampa Grande, *Rente 12* (ZSS). Manuel María Caballero Prov.: Comarapa, *Nee 46559* (MO, NY); Saipina, *Nee et al. 53697* (NY). Vallegrande Prov.: Torrecilla Río Mizque, *Betancur et al. 83* (MO). **CULTIVATED** (origin unknown): *Schumann 80* (NY); 27 Jun 1904, *Schumann s.n.* (NY); 30 Jul 1904, *Schumann s.n.* (NY); 17 Aug 1904, *Schumann s.n.* (NY); *Franck 2262, 2898* (USF).

Etymology. The protologue states that the areoles from the top to the bottom increase in the number of spines by four. The epithet has previously been suggested to mean spines in four series or that it is a misspelling of 'tephracanthus,' intended as ashy-spined (Hunt & Taylor 1987).

Discussion. *Harrisia tetracantha* is an arborescent species that consequently has the thickest trunk and constitutes the largest singular plants (with one root system) in *Harrisia*. In its native region, the most prolific flowering times seem to coincide with the peak of the wet season in December and January. The species may be well adapted to disturbance, apparently common in cleared forests with *Cleistocactus parviflorus* (K. Schum.) Gosselin (Barra Ricáldez 1998). The original material for the description in the protologue was said to be from Chuquisaca [Sucre], Bolivia from seeds supplied by Jacques Philippe Martin Cels, but no extant original material is known.

Ib. HARRISIA sect. ERIOCEREUS

Shrubs. Stems clambering, ascending, or erect, ribs 3–7. Flower buds white to reddish hairy. Pericarpel green. Hypanthium green to pinkish green. Scales deltoid to deltoid-subulate. Sepals brownish green. Fruits, tearing at sides to expose inner pulp and seed.

Five species in the Gran Chaco region (Fig. 1) and naturalized in Australia, South Africa, and Hawaii; chaco serrano, chaco arido, chaco semi-arido, chaco humedo, espinal, pantanal, pampeana; 50–1200 m; one species known only from cultivation.

This group of species is characterized by a clambering to shrubby habit with green stems, and few (3–8) ribs. In their native region, most flowering plants seem to occur during the wet season from Oct–Mar.

2. Harrisia bonplandii (Parm. ex Pfeiff.) Britton & Rose, Cact. 2: 157. 1920. *Cereus bonplandii* Parm. ex Pfeiff., Enum. Diagn. Cact. 108. 1837. *Eriocereus bonplandii* (Parm. ex Pfeiff.) Riccob., Boll. Reale Orto Bot. Palermo 8: 238. 1909. *Harrisia pomanensis* (F.A.C. Weber ex K. Schum.) Britton & Rose subsp. *bonplandii* (Parm. ex Pfeiff.) Braun & Esteves, Succulenta (Netherlands) 73: 131. 1995. **NEOTYPE** (Kiesling 1996): **Argentina**. Formosa Prov., Pilcomayo Dept., Parque Nacional Pilcomayo, 14 Dec 1988, *Guaglianone & Múlgura 2228* (SI; isoneotype: B).

Cereus acutangulus Pfeiff., Enum. diagn. Cact. 107. 1937. **NEOTYPE** (Leuenberger 2001): cult. hort. Berol., 9 Feb 1983, *Schwerdtfeger 15056* (neotype: B).

Cereus balansae K. Schum., Fl. bras. 4: 210. 1890. *Harrisia balansae* (K. Schum.) N. P. Taylor & Zappi, Cactaceae Consensus Init. 3: 7. 1997. **LECTOTYPE** (Kiesling 1996): **Paraguay**. Asunción, dans le forest, *Balansa 2504* (G; isolectotype: K, P). Holotype: B, destroyed]

Cereus guelichii Speg., Anales del Mus. Nac. Buenos Aires 11: 482. 1905. *Eriocereus guelichii* (Speg.) A. Berger, Kakteen 130. 1929. *Harrisia guelichii* (Speg.) Britton & Rose, Cact. 2: 158. 1920. **LECTOTYPE** (Kiesling 1996): Britton & Rose, Cact. 2: 158, Fig. 228. 1920. (isolectotype: NY, photo at NY is mounted along with 3 other photos presumably of same plant, "Chaco, Argentina, *Spegazzini*, Rec'd 1915").

Cereus pomanensis F.A.C. Weber ex K. Schum. var. *grossei* Weing. ex A. Berger, Kakteen 128. 1929.

Stems green. Ribs not tuberculate, 3–5, indistinct with no demarcating line at sulcus. Spines of similar length. Pericarpel and lower hypanthium areoles not similar to stem areoles. Flowers 17–24 cm long. Pericarpel green. Hypanthium light green, scales lanceolate to subulate, red-brown to green basally, with reddish hairs. Mid-hypanthium scales 3.1–4.3 × 12.4–18.2 mm. Sepals brownish green to green. Fruits without spines, retaining scales. Figs. 23–25, 85.

Distribution. Southeast Bolivia, north Argentina, and Paraguay (Fig. 1), and naturalized in Hawaii and South Africa; chaco serrano, chaco árido, chaco semi-árido, chaco húmedo, espinal, pantanal; 80–900 m (*Nee 51221*).

Specimens examined. **ARGENTINA**. BUENOS AIRES PROV.: La Plata, *Rose & Russell 21095* (US) (probably from cultivation, R. Kiesling, pers. comm.). CORRIENTES PROV.: Estancia Santa Teresa, *Pedersen 3083* (A, S, US); Teniente Ochoa, *Schinini & Palacios 25594* (G). TUCUMÁN PROV.: Trancas Dept., Vipos, *Venturi 3555* (NY, US). Jujuy Prov.: Calilegua, *Shafer 70* (G, GH, MO, NY, US). Salta Prov.: Salta, *Shafer 39* (GH, MO, NY, US). **BOLIVIA**. SANTA CRUZ DEPT.: Boyuibe, *Cárdenas 5025* (US). Andres Ibáñez Prov.: Puerto Pailas, *Nee 44863* (MO, NY); Cotoca, *Nee 37764* (MO, NY); Río Grande Planta de Gas, *Nee et al. 44630* (MO, NY); Curuyuqui, *Gentry et al. 75172* (F). Cordillera Prov.: Comunidad Salinas, *Nee 51221* (MO, NY). **PARAGUAY**. Cordillera Central, *Hassler 6850* (G). ALTO PARAGUAY DEPT.: Cerro León, *Zardini & Rivas 58334* (MO). BOQUÉRON DEPT.: Campo Loro, *Schmeda 1185* (US). DISTRITO CAPITAL: Asunción, *Shafer 138* (NY, US). GUAIRÁ DEPT.: Olimpo, *Schmeda 1460* (US). ITAPÚA DEPT.: Trinidad, *Morong 268* (NY); Isla Alta, *Schmeda 1489* (US). PARAGUARÍ DEPT.: Paraguarí, *Shafer 150* (NY, US); Cerro León, *Spichiger et al. 362* (G); *Soria & Zardini 1897* (G); Cerro Mbatoví, *Zardini & Velásquez 10043* (ASU). PRESIDENTE HAYES DEPT.: *Bernardi 20121* (G); [Estancia] Santa Elisa, *Hassler 2743* (G). **USA**. HAWAII: Kauai, Poipu Distr.: Waihoai, *Dunn & Wood 288* (PTBG). Koloa Distr.: Poipu, *Lorence & Flynn 6279* (PTBG); Poipu, *Lorence 7698* (PTBG). **CULTIVATED** (origin unknown): *Franck 2642* (USF).

Etymology. Aimé Jacques Alexandre Bonpland (1773–1858), explorer and botanist.

Discussion. *Harrisia bonplandii* has a few-ribbed stem with an undefined sulcus, moderately long spines, and a fruit with persistent scales. Its stems are often erect, achiving a greater unsupported height than other species of *Harrisia* in the Gran Chaco region. This is the only species of *Harrisia* known to occurr in the Pantanal (Eggli 2002) where it is said to be a common occurrence (Junk et al. 2006). The picture of *Harrisia* depicted by Braun & Hofacker (2006: 294, top) from the Pantanal does not conform to the morphology of *H. bonplandii*. The nearly spineless and rounded stems seem to show a defined sulcus and the flower scales are rather short (Braun & Hofacker 2006: 294, top-left). This population is deserving of additional study to determine its identification.

The name *Harrisia bonplandii* is here retained, as its modern usage appears to be fairly consistent and widely adopted. Leuenberger (2001) exhaustively detailed the history of the name and elected to maintain use of the name *H. bonplandii*. In favor of the use of *H. balansae* and contrary to Art. 51 (McNeill et al. 2012), Hunt et al. (2006) stated that the name *H. bonplandii* is "to be rejected" although no formal proposal was put forth. The lectotype designated for *H. balansae* by Taylor and Zappi (1997) was superfluous following the typification by Kiesling (1996).

3. Harrisia jusbertii (Rebut) Frič, Möllers Deutsche Gärtner-Zeitung 36: 421. 1932. *Cereus jusbertii* Rebut, Catalogue des Cactées et Plantes Grasses Diverses de la Collection de P. Rebut a Chazay-D'Azergues (Rhône) 3. 1891(?). *Eriocereus jusbertii* (Rebut) Riccob., Boll. Reale Orto Bot. Palermo 8: 240. 1909. ×*Harrisnopsis jusbertii* (Rebut) P.V. Heath, Calyx 1: 111. 1992. ×*Eriocereopsis jusbertii* (Rebut) Doweld, Tsukkulenty 4: 34. 2001. **NEOTYPE** (Franck 2012b): accession no. 746, 18 Jul 1963, *Kimnach s.n.* (HNT [1739]). Figure 28.

Stems green. Ribs not tuberculate, 3–5, indistinct with no demarcating line at sulcus. Spines of similar length, and very short, to 5 mm long, very rarely longer. Pericarpel and lower hypanthium areoles not similar to stem areoles. Flowers 17–24 cm long. Pericarpel green. Hypanthium light green, scales lanceolate to subulate, red-brown to green basally. Mid-hypanthium scales 3.1–4.3 × 12.4–18.2 mm. Sepals brownish green to green. Fruits without spines, retaining scales. Figs. 26–28.

Distribution. Known only from cultivation.

Etymology. Presumably honoring someone by the name of "Jusbert" or "Joubert".

Discussion. For simplicity, *Harrisia jusbertii* is here recognized as a species, known only from cultivation and often used as a grafting stock. This taxon is often called a hybrid, but there is presently no corroborating evidence apart from the claims of others. The distinctively short, thick (~1–2 mm wide), conical blackish spines are diagnostic for *H. jusbertii*. It seems most related to *H. bonplandii* and perhaps is a cultivar or hybrid derived from it. Its characters are similar to *H. bonplandii*, such as the flowers, the dehiscent fruit with persistent scales (Haage 1963), the green stem often lacking a well-defined sulcus, the acicular juvenile spines, and often having 4–5 ribs. As short spines are also found on mature stems in *H. martinii* and *H. regelii*, perhaps these species are involved in its origin, but this is merely speculative.

Various other taxa have been hypothesized to be part of the genome of *Harrisia jusbertii*, but none are substantiated. The description from Schumann (1899: 137–138) gave origins of Argentina or Paraguay with material being in the collection of Hermann Gruson of Magdeburg, Germany. The species was alleged to originate from Abbé Beguin (of Brignoles, France), who claimed it to be a hybrid between unnamed taxa of an *Echinopsis* s. lat. and a *Harrisia* (Berger 1905), which would make ×*Harrisnopsis* the preferred generic name. This scenario seems highly unlikely as all the vegetative characters are quite consistent with known species of *Harrisia*, except that the spines never elongate. Young spines of *Harrisia* are often blackish at the base as in the spines of *H. jusbertii*. The flowers are very much like *Harrisia* and quite unlike *Echinopsis* s. lat. It has been postulated that it is a chimeric mutant of *H. bonplandii* (Rowley 1980), though the morphology is consistent on a plant. Additionally, the seeds are viable and retain the same phenotype (Haage 1963). Henke (1981) claimed to have produced this hybrid by crossing *Echinopsis eyriesii* Pfeiff. & Otto and *Echinocereus pentalophus* (DC.) Haage var. *procumbens* (Engelm.) P. Fourn., which seems extremely doubtful (Drawert 1983).

As far as is known, *Cereus jusbertii* was first published by Rebut (1891?; Fig. 27) in a catalogue, with a brief but sufficient description of short, black spines similar to "*Cereus palmeri*." Schumann (1899: 137–138) then provided a more detailed description and furnished an illustration. Frîc (1932) was apparently the first to make the combination *Harrisia jusbertii* with an indirect reference to the basionym *Cereus jusbertii*. Britton & Rose (1920: 158) made the suggestion that *C. jusbertii* belonged in *Harrisia* but never validated the actual combination.

4. Harrisia martinii (Labour.) Britton, Addisonia 2: 55. 1917. *Cereus martinii* Labour. Annales Soc. Hort. Haute-Garonne 1: 182. 1854. *Eriocereus martinii* (Labour.) Riccob., Boll. Reale Orto Bot. Palermo 8: 241. 1909. **NEOTYPE** (designated by Kiesling 1996): **Argentina**. Entre Ríos Prov., Colón Dept., Colón, 6 Feb 1985, *Kiesling 5069* (SI; isoneotype: CTES).

Cereus martinii Labour. var. *perviridis* Weing., Monatsschr. Kakteenk. 24: 72. 1914. *Harrisia perviridis* (Weing.) Borg, Cacti: a gardener's handbook for their identification and cultivation 145. 1937. **TYPE**: **Paraguay**. [Guairá Dept.], Estancia San Salvador, *Anisits 50*.

Stems green. Ribs tuberculate, 4–5, separated by a distinct line at sulcus. Central spines 1–4, 1.5–2 times as long as radial spines. Flowers 18–26 cm long. Pericarpel green, having areoles similar to stem areoles with spines and without scaly trichomes. Hypanthium green to reddish green, scales red-purple, deltoid, with white hairs, lower areoles often similar to stem areoles with spines and without scaly trichomes. Mid-hypanthium scales 1.3–3.8 × 2.7–4.9 mm. Sepals green to pinkish green. Fruits often spiny, scales deciduous. Figs. 17, 29–37.

Distribution. Southeast Paraguay and northeast Argentina (Fig. 1), and naturalized in Australia, South Africa, and Hawaii; chaco húmedo, espinal; 50–100 m.

Specimens examined. **ARGENTINA**. May 1904, *Weber s.n.* (P). CHACO PROV.: Colonia Benitez, *Krapovickas 15787* (P). CORRIENTES PROV.: Mburucyá Dept., *Pedersen 5871* (A, US); San Cosme, *Leuenberger & Arroyo 3969* (ZSS). FORMOSA PROV.: Patiño Dept., *Charpin & Eskuche 20342* (G). SANTA FE PROV.: San Cristóbal Dept., Ceres a Arrufó, *Kiesling 8365* (NY, P). **AUSTRALIA**. QUEENSLAND. Brisbane: Leichhardt, 7 Nov 2004, *Batianoff s.n.* (BRI). Darling Downs: Goondiwindi, *Telford 8875* (BRI). Moreton: Mt. Crosby Road, *Booth 5384* (BRI). **PARAGUAY**. CONCEPCIÓN DEPT.: Concepción, *Hassler 7388* (BM, G). ITAPÚA DEPT.: Trinidad, *Shafer 132* (NY, US). PRESIDENTE HAYES DEPT.: *Hahn 2152* (MO). **SOUTH AFRICA**. KWAZULU-NATAL PROV.: Ashburton, 18 Mar 1970, *Wells s.n.* (MO); Ashburton, May 1973, *Paterson s.n.* (PRE); near Pietermaritzburg, Jul 1975, *Pickworth s.n.* (PRE); Pietermaritzburg Distr., 13 Sep 1965, *Pickworth s.n.* (PRE); Ashburton area, Jul 1967, *Regional Officer s.n.* (PRE). WESTERN CAPE PROV.: Hout Bay, s.d., *Succulenta Nurseries s.n.* [cultivated?] (PRE). **USA.** HAWAII: Kauai: Koloa Distr.: Poipu, *Lorence 7697* (PTBG); Poi'pu Road, *Lorence 7987* (PTBG). Poipu Distr.: near Waiohai, *Dunn & Wood 303* (PTBG).

Etymology. Raymond Martin (?–?), cactus horticulturist.

Discussion. *Harrisia martinii* has a few-ribbed stem and short radial spines that are often present on the pericarpel, lower hypanthium, and fruit. The stems and fruit are often prominently tuberculate. It is the most successful species to naturalize outside of its native range, occurring in South Africa, Australia, and Hawaii. The authorship of *H. martinii* was confirmed by Leuenberger (2000a).

Based on Rec. 60C.2 in McNeill et al. (2012), "martini" as in *"Harrisia martini*" would be the preferred name over "*H. martinii.*" Since this is merely a recommendation and the spelling "*H. martinii*" is most common, I have retained the popular spelling.

5. Harrisia pomanensis (F.A.C. Weber ex K. Schum.) Britton & Rose, Cact. 2: 155. 1920. *Cereus pomanensis* F.A.C. Weber ex K. Schum., Gesamtbeschr. Kakt. 136. 1899. *Echinopsis pomanensis* (F.A.C. Weber ex K. Schum.) Anceschi & Magli, cactusinhabitat 39. 2013. **NEOTYPE** (designated by Kiesling 1996): **Argentina**. Santiago del Estero Prov., Ojo de Agua Dept., Quebrada de Pozo Grande, 18 Dec 1981, *Ulibarri 1366* (SI; isoneotype: SI).

Eriocereus polycanthus F. Ritter, Kakteen in Südamerika 2: 436. 1980. **TYPE**: **Argentina**. Catamarca, *F. Ritter 413* (holotype: U, not found).

Eriocereus tarijensis F. Ritter, Kakteen in Südamerika 2: 557. 1980. *Harrisia pomanensis* (F. A. C. Weber ex K. Schum.) Britton & Rose subsp. *tarijensis* Braun & Esteves, Succulenta (Netherlands) 73: 131.1995. **TYPE**: **Bolivia**. [Chuquisaca Dept.], Puente Azero, Grenze der Provinzen Azero und Tomina, *F. Ritter 619* (holotype: U, not found).

Stems glaucous green. Ribs not tuberculate, 4–6, separated by conspicuous line at sulcus. Spines of similar length. Pericarpel and lower hypanthium areoles not similar to stem areoles. Flowers 14–21 cm long. Pericarpel green. Hypanthium green, scales reddish green, lanceolate to subulate. Mid-hypanthium scales 4.0–5.0 × 13.6–18.3 mm. Sepals pale reddish green. Fruits without spines, scales usually withering-deciduous. Figs. 4, 38–42.

Distribution. Southeast Bolivia, west Paraguay, and northwest Argentina (Fig. 1) and naturalized in South Africa; chaco serrano, chaco árido, chaco semi-árido (Zak & Cabido 2002); 200–1200 m.

Specimens examined. **ARGENTINA**. CATAMARCA PROV.: *Leuenberger 4362* (USF). CÓRDOBA PROV.: Villa de Maria, *Leuenberger & Eggli 4639* (ZSS); Cruz del Eje, *Leuenberger & Eggli 4710* (ZSS); Cruz del Eje, *Leuenberger & Eggli 4485* (ZSS). TUCUMÁN PROV.: Trancas, 3 Dec

2003, *Leuenberger & Eggli 4901* (ZSS). **BOLIVIA**. SANTA CRUZ DEPT.: Caballero Prov.: Río Quiñal, *Saldias & Medellín 4409* (NY); Cordillera Prov.: Ipatí, *Nee 51239* (NY). TARIJA DEPT.: Yacuiba, *Pensiero & Marino 4475* (MO). **CULTIVATED** (origin unknown): *Franck 2640* (USF).

Etymology. Poman, pertaining to a place in Argentina, perhaps Pomancillo or Pomán.

Discussion. *Harrisia pomanensis* has a defined sulcus between the ribs, which can sometimes be difficult to see on specimens. It is also characterized by its spines normally being of a relatively similar length and having a spineless fruit with usually withering-deciduous scales.

6. Harrisia regelii (Weing.) Borg, Cacti: a gardener's handbook for their identification and cultivation 145. 1937. *Cereus regelii* Weing., Monatsschr. Kakteenk. 20: 33. 1910. *Eriocereus martinii* (Labour.) Riccob. var. *regelii* (Weing.) W.T. Marshall, Cactaceae, with illustrated keys of all tribes, sub-tribes and genera 98. 1941. *Eriocereus regelii* (Weing.) Backeb., Die Cactaceae 4: 2093. 1960. *Harrisia pomanensis* (F.A.C. Weber ex K. Schum.) Britton & Rose var. *regelii* R. Kiesling, Darwiniana 34: 395. **NEOTYPE** (designated by Leuenberger 1996): **Germany** [cultivated]. Berlin-Dahlem Botanical Garden, 10 Aug 1994, *Schwerdtfeger 12552a* (B; isoneotype: SI).

Stems green. Ribs tuberculate, 4–5, not separated by conspicuous line at sulcus. Central spines 1–4, 1.5–2 times as long as radial spines. Flower buds with reddish hairs. Flowers 19–22 cm long. Pericarpel and lower hypanthium areoles not similar to stem areoles. Pericarpel green. Hypanthium green, scales red to reddish green, deltoid-lanceolate. Mid-hypanthium scales 2.6–4.2 × 7.9–11.5 mm. Sepals pale reddish green. Fruits not spiny, scales deciduous or sometimes persistent. Figs. 5–6, 13, 43–45.

Distribution. Entre Ríos Province, Argentina (Fig. 1), reportedly naturalized in Queensland, Australia (Leuenberger 2000b; Paskins 2001); espinal; ~50 m.

Specimens examined. **CULTIVATED** (origin unknown): 19 Jun 2008 & 23 Sep 2008, *Franck s.n.* (USF); *Franck 2629*, *2662* (USF).

Etymology. Eduard August von Regel (1815–1892), botanist.

Discussion. *Harrisia regelii* has short radial spines like *H. martinii*, which it was noted as a possible variety of (Borg 1937; Hunt et al. 2006). Unlike *H. martinii*, areoles of the pericarpel and lower hypanthium of *H. regelii* typically have reddish scaly hairs and no spines. These two species are often confused and *H. regelii* appears to be common in cultivation. Kiesling (1996) regarded *H. regelii* as a variety of *H. pomanensis*, though Leuenberger (1995, 2000b) and Hunt et al. (2006) maintained it as a species. Both Kiesling (1996) and Leuenberger (2000b) identified specimens of this species from Entre Ríos Province, Argentina; previously this species had been known only from cultivation. *Harrisia regelii* is sympatric with *H. bonplandii* (Kiesling 1996; Leuenberger 2000b) while *H. pomanensis* is apparently widely disjunct (Fig. 1).

It seems possible that *Harrisia regelii* involves crosses between *H. bonplandii* and *H. martinii*. The angular ribs and occasional lack of a defined sulcus (Figs. 44–45) and fruit with persistent red scales (Fig. 43) are reminescent of *H. bonplandii* while the short radial spines (Figs. 43–45), occasionally defined sulcus (Fig. 43), tuberculate stems (Figs. 43–45), and tuberculate fruit (Fig. 45) seem similar to *H. martinii*. Its similarity to *H. pomanensis* (Fig. 43) cannot wholly be discounted, though this species is not known from the region (Fig. 1). It is not entirely clear that Figs. 43–45 are conspecific and ideally molecular data would be useful to clarify taxonomic relationships among these specimens and others in sect. *Eriocereus*.

7. Harrisia tortuosa (J. Forbes ex Otto & A. Dietr.) Britton & Rose, Cact. 2: 154. 1920. *Cereus tortuosus* J. Forbes ex Otto & A. Dietr., Allg. Gartenzeitung 6: 35. 1838. *Eriocereus tortuosus* (J. Forbes ex Otto & A. Dietr.) Riccob., Boll. Reale Orto Bot. Palermo 8: 245. 1909. **NEOTYPE** (Kiesling 1996): **Argentina**. Corrientes Prov., San L. del Palmar Dept., 18 km SE de San Luis del Palmar, 2 Nov 1979, *Schinini 19451* (CTES; isoneotype: SI).

Cereus arendtii Hildmann & Mathsson ex K. Schum., Monatsschr. Kakteenk. 4: 173. 1894. *Eriocereus arendtii* (Hildmann & Mathsson ex K. Schum.) F. Ritter, Kakteen in Südamerika 1: 242. 1979. **NEOTYPE** (designated here): **Argentina**. Corrientes Prov., San L. del Palmar Dept., 18 km SE de San Luis del Palmar, 2 Nov 1979, *Schinini 19451* (CTES; isoneotype: SI).

Cereus atropurpureus Hocay, Cacteencult 91. 1916.

Stems green. Ribs tuberculate, 6–8, separated by conspicuous line at sulcus. Spines of similar length. Flowers 19–22 cm long. Pericarpel brownish green, sometimes having areoles similar to stem areoles with spines and without scaly trichomes. Hypanthium pale pinkish green, scales red, ovate, with white hairs, sometimes the lower hypanthium areoles similar to stem areoles with spines and without scaly trichomes. Mid-hypanthium scales 2.2–3.4 × 5.7–7.6 mm. Sepals pale pinkish green-brown. Fruits with or without spines, scales deciduous. Figs. 46–49.

Distribution. Paraguay, northeast Argentina, and west Uruguay (Fig. 1) and naturalized in Australia; chaco húmedo, espinal; 80-300 m.

Specimens examined. **AUSTRALIA**. QUEENSLAND. Darling Downs: Boondandilla State Forest, *Forster 29482* (BRI). **ARGENTINA**. BUENOS AIRES: May 1904, *Weber s.n.* (P). **PARAGUAY**. CORDILLERA DEPT.: Río Piribebuy, *Zardini & Velazquez 19789* (MO). **URUGUAY**. MONTEVIDEO DEPT.: Montevideo, Apr 1836, *Gaudichaud s.n.* (P). RÍO NEGRO DEPT.: Estancia Nueva Mehlem, en limo pampeano, collected in 9 Apr 1922, *Schroeder s.n., Herb. Osten 16720* (MVM). **CULTIVATED** (origin unknown): *Franck 1281, 2628, 2897* (USF).

Etymology. Tortuous, twisting, winding.

Discussion. *Harrisia tortuosa* and *H. martinii* are the only taxa of *Harrisia* with stem-like areoles on the pericarpel, often being spiny. However, with its 6–8 ribs and longer radial spines, *H. tortuosa* is readily differentiated from *H. martinii*. Spination may be variable on the pericarpel, as a flower illustration (Fig. 49, Britton & Rose 1920) and a fruit specimen (Osten 1941) appear spineless.

Harrisia tortuosa is the only species in the genus known from Uruguay. The name *Harrisia tortuosa* var. *uruguayensis* was never given a Latin diagnosis and is illegitimate. The specimens ascribed to this name have 6–8 ribs, which agrees with its placement under *H. tortuosus*. The specimens at MVM also appear to have spiny pericarpels, but apparently the fruits may appear spineless (Osten 1941). Backeberg (1960) and Kiesling (1996) allied this specimen with *H. pomanensis*; however, the range of *H. tortuosa* var. *uruguayensis*, nom. illeg., is more agreeable with *H. tortuosa*.

Cereus arendtii is here regarded as a later synonym of *Harrisia tortuosa* as done by others (e.g. Schumann 1899; Britton & Rose 1920; Backeberg 1960; Aarsen 1983.), although the protologue of *C. arendtii* only mentioned a similarity to *H. tortuosa* and did not initially synonymize the two. The protologue of *C. arendtii* described a specimen having six ribs with shallow sulci, tuberculate areoles, and spines 2–3 cm long. This description is consistent with the morphology of *H. tortuosa* but does not distinguish it from many other species of cacti such as *H. pomanensis*. The provenance of *C. arendtii* was given as "Thale von Cordova in Uruguay" and only *H. tortuosa* is known from

Uruguay. I have been unable to confidently associate "Thale von Cordova" with any place in Uruguay (see Ritter 1979: 243). I have found only one reference to a place "Cordova" in Uruguay for the London & River Plate Bank (Homans 1874: 185). As Schumann (1899) recognized *H. pomanensis* and *H. tortuosa* as distinct and listed *C. arendtii* as a synonym of *H. tortuosa*, it is presumed this is consistent with the present treatment. It could be possible to interpret *C. arendtii* as actually from Córdoba, Argentina and more consistent with *H. pomanensis*. Therefore I proffer a neotype for *C. arendtii* to secure its application to *H. tortuosa*.

Ritter (1979: 242) chose to recognize *Eriocereus arendtii* and excluded *Cereus tortuosus* from *Eriocereus* (= *Harrisia*), suggesting it to more likely be a member of *Piptanthocereus* (A. Berger) Riccob. (= *Cereus* Mill. s. str.) and perhaps synonymous with *C. aethiops* Haw. *Harrisia tortuosa* has been neotypified (Kiesling 1996) and is in common usage for a cactus occurring in northeast Argentina, east Paraguay, and west Uruguay (Anderson 2001; Hunt et al. 2006; Franck 2012b). Reports of *H. tortuosa* in Bolivia are so far unverified by herbarium specimens (Kiesling et al. 2014).

II. HARRISIA subg. HARRISIA
Cereus Mill. [unranked] *Attenuati* Salm-Dyck, Cact. Hort. Dyck.: 27. 1842 [fide Mottram 2014].

Shrubs or small trees. Stems pendent, prostrate, arching, reclining, clambering, ascending, or erect, dark green to glaucous green, 5–14 ribs. Spines to 12 cm long, 1.5 mm thick. Newly emergent spines white to yellow to red with darker tips. Seeds oblong rectangular, 1.3–2.4 × 1.9–3.35 mm.

One species is found in the caatinga of northeast Brazil and 11 species occur in the West Indies (Greater Antilles, Bahamas, southern coastal Florida) (Figs. 2 and 3), naturalized in Hawaii; seasonally dry forest and scrubland; 0–600 m.

This subgenus contains species which have oblong seeds. Salm-Dyck (1850) may have recognized the similarity between the West Indian species and the Brazilian *Harrisia adscendens* if the name he used, *Cereus platygonus*, is the same plant as *H. adscendens*. These species were placed together in the unranked group *Attenuati* under the genus *Cereus* (Salm-Dyck 1850: 45; Labouret 1853: 335).

IIb. HARRISIA sect. ADSCENDENTES A.R. Franck, Syst. Bot. 38: 218. 2013. **TYPE**: *Harrisia adscendens* (Gürke) Britton & Rose.

This section is monotypic and might have been historically more widespread given the presence of other columnar cacti in northern South America (Franck et al. 2013a).

8. Harrisia adscendens (Gürke) Britton & Rose, Cact. 2: 155. 1920. *Cereus adscendens* Gürke, Monatsschr. Kakteenk.18: 66. 1908, nom. prop. cons. *Eriocereus adscendens* (Gürke) A. Berger, Kakteen 129. 1929. **LECTOTYPE** (Taylor & Zappi 2004): **Brazil**. Bahia, Tambury, den Niederungen der catinga, Oct 1906, *Ule 7072* (B; isolectotype: HBG, K [photo]).
Cereus platygonus Otto, Cacteae Horto Dyckensis Cultae, Anno 1849: 199. 1850, nom. prop. rej. *Eriocereus platygonus* (Otto) Riccob. 8: 242. 1909. *Harrisia platygona* (Otto) Britton & Rose, Cact. 2: 156. 1920. **NEOTYPE** (Franck 2015): "K. Sch. 99" (NY [02343599]).

Shrubs. Stems arching, reclining, clambering, ascending, or erect, glaucous green, 6–10 ribs. Spines to 3 cm long, spines of basal and distal areoles similar in size. Newly emergent spines red. Pericarpel and hypanthium green, scales lanceolate to subulate, green with reddish tips. Mid-hypanthium scales 1.5–3.2 × 3.3–8.2 mm. Sepals green to pale reddish green. Petals white. Fruits

orange to red, rarely yellow-orange, tearing at sides to expose inner pulp and seed. Seeds 2–2.3 × 2.8–2.9 mm. Figs. 4, 9, 50–52.

Distribution. Northeastern Brazil (Fig. 2); caatinga; 100–600 m.

Specimens examined. **BRAZIL**. BAHIA: Juazeiro, *Rose & Russell 19730* (NY, US); Salgada, *Rose & Russell 19715* (NY, US); Barrinha, *Rose & Russell 19794* (NY); Joazeiro, *Zehntner 729* (US); Teofilandia, *Taylor et al. 1349* (ZSS); Uauá, *Taylor et al. 1362* (ZSS); Juazeiro, *Taylor et al. 1388* (ZSS); Iaçú, *Taylor et al. 1580* (ZSS); Ipirá, *Hofacker 403* (USF, ZSS). **CULTIVATED** (origin unknown): *Schumann 99* (NY); 1901, *Britton s.n.* (NY); *Franck 2641, 2896* (USF).

Etymology. Climbing, ascendant.

Discussion. *Harrisia adscendens* is characterized by its oblong seeds, glaucous stem, dehiscent fruit, and long stigma lobes. This species has been treated in detail by Taylor & Zappi (2004). The unknown *Harrisia* reported from Unaí, Brazil (Junqueira et al. 2010) might be *H. adscendens*.

The name *Cereus platygonus* is here interpreted as conspecific with *Harrisia adscendens*. *Cereus platygonus* would have priority as an earlier published name, but it has been proposed and recommended for rejection (Franck 2015; Taxon 65: 1159. 2016.) since it was abandoned after being used by Riccobono (1909) and Britton & Rose (1920).

IIb. HARRISIA sect. HARRISIA

Shrubs or small trees. Stems pendent, prostrate, arching, reclining, clambering, ascending, or erect, dark to light green, 5–14 ribs. Spines to 12 cm long, spines of basal and distal areoles sometimes dissimilar in size. Newly emergent spines white to yellow to red. Pericarpel and hypanthium scales green to brownish to reddish, deltoid to lanceolate, sepals lanceolate. Petals white to pinkish. Fruits yellow to red, indehiscent. Seeds 1.25–2.0 × 2.0–3.35 mm.

Four species occur in Cuba, two in Florida, one (or two?) on Hispaniola, one in Puerto Rico, one in the Bahamas, one in Jamaica, and one in the Cayman Islands and the Swan Islands (Fig. 3), naturalized in Hawaii; scrubland and scrub forest; 0–400 mm.

IIb-1. HARRISIA ser. EARLEI A.R. Franck, Syst. Bot. 38: 218. 2013. **TYPE**: *Harrisia earlei* Britton & Rose.

It seems quite probable that this series was once more diverse or widespread historically, perhaps sympatric with other species of *Hylocereus* (A. Berger) Britton & Rose and *Strophocactus* Britton & Rose that occupy similar habitats, found prostrate on boulders in Central America and Mexico (Franck et al. 2013a).

9. Harrisia earlei Britton & Rose, Cact. 2: 154. 1920. **TYPE**: **Cuba**. Pinar del Río Prov., San Diego de los Baños, limestone rocks, 31 Aug–3 Sep 1910, *Britton et al. 6667* (holotype: NY).

Shrubs. Stems pendent, prostrate, clambering, only young stems ascending, or erect, 5–7 ribs. Young spines bright red with darker tips, becoming black to gray. Pericarpel green. Hypanthium light green, scales brownish, with reddish tips, deltoid to ovate. Mid-hypanthium scales 1.6–2.2 × 6.0–9.3 mm. Sepals pale yellow-greenish with brown-red tips. Immature fruit green. Fruits yellow. Seeds 1.65–1.8 x 2.55–2.95 mm. Fig. 53.

Distribution. Pinar del Rio Provínce, Cuba (Fig. 3); scrub forest over limestone boulders; 100–400 m.

Specimens examined. **CUBA**. PINAR DEL RÍO PROV.: Pan de Azucar, *Morton s.n.* (HNT, UC, US); Sumidero, *Shafer* [& *León*] *13397* (GH, HAC, NY, P, US); Sumidero, *Ekman 18222* (S); Río Guao, *Britton et al. 9653* (NY, US); Sierra Guayaba, *Shafer 13862* (NY, US); Sierra Guane, *Shafer 10524* (NY, US); Viñales, *Ardisson 99.15* (USF); San Diego de Los Baños, *Agathange 5045* (HAC, NY); San Diego de los Baños, *Earle s.n.* (NY); Guane, *Britton et al. 9747* (NY); San Diego de los Baños, *León 4231* (NY); 2 May 2006, *ZSS staff s.n.* (ZSS).

Etymology. Franklin S. Earle (1856–1929), mycologist.

Discussion. *Harrisia earlei* is the most distinctive species in the West Indies with its prostrate habit, 5–7 ribs, and reddish newly emergent spines. A description of the flowers was provided by Delanoy (2005) and a description of its habitat by Ardisson & Delanoy (2002).

IIb-2. HARRISIA ser. HARRISIA

Shrubs or small trees. Stems arching, reclining, clambering, ascending, or erect, 8–14 ribs. Spines to 8 cm long. Young spines white to straw-colored basally, becoming brown to red-black with a black tip, eventually becoming gray. Pericarpel green to red. Hypanthium yellow-green to green to red. Scales yellow-green to green to red. Sepals yellow-green to pale red. Fruits yellow to red. Seeds 1.25–2.0 × 2.0–3.35 mm.

Three species occur in Cuba, two in Florida, one (or two?) on Hispaniola, one in Puerto Rico, one in the Bahamas, one in Jamaica, and one in the Cayman Islands and the Swan Islands (Fig. 3), and an unknown species naturalized in Hawaii (*Dunn & Wood 298* (PTBG) and *Lorence 7623a* (PTBG)); scrubland and scrub forest; 0–400 m.

This study favors recognition of 10 species of series *Harrisia* in the West Indies. Four names that are sometimes recognized are here put into synonymy (*H. hurstii*, *H. nashii*, *H. simpsonii*, *H. taylorii*).

Most of the West Indian species are allopatric and morphologically uniform. Further morphological and molecular work in the West Indies would be ideal to verify taxonomic delimitation across multiple populations. The northwestern group of species (*Harrisia aboriginum* , *H. eriophora*, *H. fernowii*, *H. fragrans*, and *H. taetra*) all share relatively large seeds (1.7–2.2 × 2.6–3.35) and reddish coloration in the flowers. The other species of the West Indies (*H. brookii*, *H. caymanensis*, *H. divaricata*, *H. gracilis*, and *H. portoricensis*) are united by relatively small seeds (1.4–1.7 × 2.0–2.8 mm) and predominantly greenish flowers.

Characterization of the flower and overall spine morphology (especially at the base of plants in habitat) is critical for identification. Fresh, mature flowers of very few specimens have been studied and additional observations are desirable. Many morphological characters (flower bud shape, trichome color, petal margins, and stem thickness) which were claimed as diagnostic by others (e.g. Britton 1908; Britton & Rose 1920) are here abandoned because their utility is questionable or difficult to apply.

Flower buds of some species were distinguished as being depressed-truncate, subglobose, obovoid, or ovoid (Britton 1908; Britton & Rose 1920). The shape of the flower bud varies greatly as it ages and matures. This character is very difficult to assess or apply without having some indication of the age of the flower bud and measurements on its dimensions. Britton (1908) alleged pointed

buds with curled hairs in some species, being obovoid in *Harrisia divaricata* (as *H. nashii*), ovoid in *H. brookii*, and subglobose in *H. fernowii* (as *H. taylorii*). Buds of *H. portoricensis* were stated to be rounded-truncate with curled hairs. Britton (1908) described pointed buds with straight hairs in *H. gracilis*.

Two species, *Harrisia aboriginum* and *H. fernowii*, were described as having tawny trichomes, probably an artifact of aging, as all observations of living material show white trichomes on the flowers (Hooten 1991; pers. obs.). Furthermore, all old herbarium specimens seem to have tawny trichomes. Additionally, the short, uniseriate trichomes of the stem areoles of many species can be tawny when first emerging (Fig. 95).

Flower petals margins have been described as denticulate or entire and used to characterize certain species (Britton 1908; Britton & Rose 1920). The margins of the flower petals of all species appear irregularly denticulate to varying degrees. None appear strictly entire and this character is very difficult to apply. The petals are delicate and thin, and as such, their margins are not well preserved on herbarium specimens. Multiple observations would be needed to verify if petal margins are consistently distinct between species. Entire petals were purported for *Harrisia brookii*, *H. divaricata* (as *H. nashii*), *H. eriophora, H. fragrans, H. portoricensis* and denticulate petals for *H. gracilis* and *H. fragrans* (as *H. simpsonii*) (Britton 1908; Britton & Rose 1920).

Stem thickness has also been used (Areces 1980) based upon the original descriptions (Britton 1908). This character widely varies with age, health, vigor, and the degree of hydration of the stem (Eggli & Giorgetta 2015) and it is difficult to conceive how this measurement could be standardized. Perhaps the distal mature stems of healthy, hydrated plants may be worthwhile to study.

10. Harrisia aboriginum Small ex Britton & Rose, Cact. 2: 154. 1920. *Cereus aboriginum* (Small ex Britton & Rose) Little, Amer. Midl. Naturalist 33: 495. 1945. *Cereus gracilis* Mill. var. *aboriginum* (Small ex Britton & Rose) L.D. Benson, Cact. Succ. J. (Los Angeles) 41: 126. 1969. *Harrisia gracilis* (Mill.) Britton var. *aboriginum* (Small ex Britton & Rose) D. B. Ward, Novon 14: 366. 2004. **LECTOTYPE** (Benson 1969): **USA**. Florida, [Manatee Co.], western shore Terra Ceia Island, hammock, 29 Apr 1919, *Small et al. s.n.* (NY; isolectotype: US).

Shrubs, trunk not evident or poorly developed. Spines not crowded, not overlapping spines of adjacent areoles, shorter than width of the stem, to 1.5 cm, 0.5 mm thick, spines of similar size on distal and basal areoles of stems. Flowers 18 cm long. Pericarpel green. Hypanthium pinkish brown, scales pinkish brown to red-brown, deltoid to deltoid-ovate. Mid-hypanthium scales 1.6–2.0 × 4.5–8.0 mm. Sepals pale pink. Immature fruit green and lightly tuberculate, turning orange and smooth near maturity. Mature fruit yellow, smooth. Seeds 1.7–2.0 × 2.7–3.0 mm. Figs. 54–58.

Distribution. Gulf coast, central peninsula of Florida, USA (Fig. 3); coastal strands and maritime hammock, on sandy or shell fragment soils; 0–5 m.

Specimens examined. **USA.** FLORIDA: Lee Co.: Buck Key, *Hooten s.n.* (US); Buck Key, 29 Oct 2007, *Franck s.n.* (USF); Buck Key, *Possley & Fellows 29* (FTG); Bokeelia Island, Jun 2007, *Franck s.n.* (USF); Buck Island, *Austin & Austin 6863* (FTG). Manatee Co.: Terra Ceia Island, 1917, *Swingle s.n.* (US); Terra Ceia, Jan 1920, *Robinson s.n.* (K). Sarasota Co.: Osprey, 1906, *Webb s.n.* (US); Osprey, 1911, *Webb s.n.* (NY); Longboat Key, *Lakela & Long 28145* (USF); Manasota Key, *Hansen & Richardson 6819* (USF); Longboat Key, *Lakela & Long 27609* (FLAS, USF); Little

Sarasota Key, *Coville 24* (US); Manasota Key, *Beckner 1715* (FLAS); Manasota Key, *Franck 1237* (USF); Longboat Key, Jun 2007, *Franck s.n.* (USF).

Etymology. For the "shell heaps formed by the aborigines" (Britton & Rose 1920).

Discussion. *Harrisia aboriginum* can be recognized by its consistently short spines, brownish hypanthium, green pericarpel, green immature fruit, and yellow mature fruit. The fruits often seem to change from green (immature) to orange (maturing) to yellow (fully mature). Vegetatively *H. aboriginum* is most like two other short-spined species, *H. gracilis* and *H. fragrans*, although longer spines are also observed in these two (< 3.5 cm).

Hooten (1991) used a strict interpretation of the protologue (i.e., tawny hairs) of *Harrisia aboriginum* to attempt to name a new species (*H. donae-antoinae*, nom. inval.) because of the white hairs observed in fresh material. All flower hairs seem to age to a tawny color on herbarium specimens, including the intended type specimen of *H. donae-antoinae*, nom. inval., making it agreeable with the sense of *H. aboriginum* in morphology and distribution. The name *H. donae-antoinae* is invalid as Hooten (1991) did not clearly designate a type specimen and then did not give a clear reference to the page number that gave the Latin diagnosis (Hooten 1992).

11. Harrisia brookii Britton, Bull.Torrey Bot. Club 35: 564. 1908. *Cereus brookii* (Britton) Vaupel, Monatsschr. Kakteenk. 23: 24. 1913. **TYPE**: **Bahamas**. Long Island, Clarence Town and vicinity, scrublands, 16–19 Mar 1907, *Britton & Millspaugh 6337* (holotype: NY; isotype: US). **EPITYPE** (Franck 2012b): **Bahamas**. Near Mortimers, dry open coppice on high rocky ridge, 24 Apr 1980, *Correll 51278* (FTG; isoepitype: NY).

Shrubs, trunk not evident or poorly developed. Spines of distal areoles sometimes overlapping spines of adjacent areoles, shorter than width of stem, to 1.5 cm long and 0.3 mm thick, spines of basal areoles somewhat crowded and overlapping, to 3 cm long and 0.6 mm thick. Flowers to 20 cm long. Pericarpel green. Hypanthium green to reddish, scales yellow-green to green distally, lanceolate to subulate. Mid-hypanthium scales 2.8–3.2 × 14.8–15.4 mm. Sepals pinkish brown-green. Immature fruit green, tuberculate. Mature fruit yellow, oblong, ellipsoid, lightly tuberculate. Seeds 1.55–1.7 × 2.65–2.85 mm. Figs. 59–62.

Distribution. Bahamas (Fig. 3); scrublands (Correll & Correll 1982) or coastal coppice (Correll 1979); 0–20 m.

Specimens examined. **BAHAMAS**. ELEUTHERA ISLAND: *Vincent 13393* (MU). LONG ISLAND: Clarence Town, *Britton & Millspaugh 6337* (NY,US); Mortimers, *Correll 44980* (FTG); Mortimers, *Franck 3033, 3116* (USF); Clarence Town, *Hill 2291* (FTG, NCU); Clarence Town, 11 May 1974, *O'Kelly s.n.* (A); Deadman's Cay, *Correll 45038* (FTG). NEW PROVIDENCE ISLAND: *Robinson 475* (K).

Etymology. Hon. Herbert A. Brook, Registrar of the Bahamas.

Discussion. *Harrisia brookii* can be recognized by its pinkish sepals, ellipsoid fruit (Vincent 2007), and spines that only become slightly longer and thicker on the lower stem. Only one flower has been observed for characterization of this species here. *Harrisia divaricata* is sometimes observed with ellipsoid fruits, but this species also seems to have strongly tuberculate immature fruits and longer, thicker spines on the lower stem compared to *H. brookii*. The scales of *H. brookii* are possibly consistently longer (14.8–15.4 mm long, again based on one flower) than those in *H. divaricata*. Although there is a specimen labeled year 1880 from New Providence Island (*Robinson 475*), recent observations have been made only from Eleuthera and Long Island. Correll & Correll

(1982) mentioned that the specimen *G.R. Proctor 8812* (IJ) from Grand Turk is possibly referable to this species, but the specimen was not located in a recent search at IJ. *Harrisia* should be searched for and characterized in the Turks and Caicos Islands.

12. Harrisia caymanensis A.R. Franck, Haseltonia 18: 98. 2012. **TYPE**: **Cayman Islands**. Cayman Brac, cutting grown in Florida, 10 June 2012, *A. R. Franck 3035* (holotype: USF; isotype: MO).

Shrubs, trunk not evident or poorly developed. Spines of distal areoles often overlapping those of adjacent areoles, often as long or longer than stem width, to 2.5 cm long and 0.5 mm thick, spines of basal areoles crowded and overlapping, to 6.5 cm long and 0.7 mm thick. Flowers to 15 cm long. Pericarpel green. Hypanthium light green, scales light green to green, ovate-lanceolate. Mid-hypanthium scales 2.1–2.7 × 8.5–10.0 mm. Sepals greenish brown. Immature fruit green, lightly tuberculate. Mature fruit yellow, smooth. Seeds 1.4–1.5 × 1.9–2.1 mm. Figs. 63–65.

Distribution. Cayman Islands, and Swan Islands, Honduras (?) (Fig. 3); coastal scrub and scrubby woodland on exposed limestone rock; 5–50 m.

Specimens examined. **CAYMAN ISLANDS**. CAYMAN BRAC: *Franck 2370*, *2371*, *2622*, *2630* (USF). **HONDURAS** (?). SWAN ISLANDS: Little Swan, 30 Jul 1974, *Clough s.n.* (IJ); Eastern Swan Island, 14 Nov 1973, *Moyne s.n.* (K).

Etymology. For the Cayman Islands.

Discussion. The shortest flowers in the genus occur in *Harrisia caymanensis*. This species is also characterized by long spines on the lower stem areoles and relatively small seeds. The flower color and shape of the hypanthium scales suggests an affinity with *H. fernowii*. The name *H. gracilis* had previously been misapplied to *H. caymanensis* (Adams 1972; Proctor 1984; Proctor 2012). The population of *Harrisia* on the Swan Islands, previously identified as *H. eriophora* (Sandoval et al. 2007), represents the most isolated occurrence of *Harrisia* and is here tentatively referred to *H. caymanensis* (Franck 2012b). The Swan Islands population needs additional study (i.e. the flower length, color of the flower parts, seed size, maximum spine width and length) to determine if it is conspecific with *H. caymanensis* or represents a differet taxon.

13. Harrisia divaricata (Lam.) Backeb., Die Cactaceae 4: 2101. 1960. *Cactus divaricatus* Lam., Encycl. 1: 540 1783. *Cereus divaricatus* (Lam.) DC., Prodr. 3: 466. 1828. *Pilocereus divaricatus* (Lam.) Lem., Rev. Hort. (Paris) 427. 1862. **LECTOTYPE** (Lourteig 1991): **Haiti**. Cul-de-sac, near Léogâne, Plumier illustration. Reproduced in Burman 1758, *Pl. Amer.* 8: tab. 193; in Hunt 1984, p. 57–58; and in Mottram 2002, p. 110–111.

Cereus divergens Pfeiff., Enum. diagn. Cact. 95. 1837. **TYPE**: Dominican Republic, Santo Domingo.

Harrisia nashii Britton, Bull.Torrey Bot. Club 35: 564. 1908. *Cereus nashii* (Britton) Vaupel, Monatsschr. Kakteenk. 23: 27. 1913. **TYPE**: **Haiti**. Between Gonaives and Plaisance, 1905, flowered [at] New York Botanical Garden 11 Jul 1907, *Nash & Taylor 1765* (holotype: NY).

Harrisia nashii Britton var. *straminea* W.T. Marshall, Cact. Succ. J. (Los Angeles) 15: 3. 1943. **TYPE**: **Dominican Republic**. Monte Cristi Prov., Hurst finca near Monte Christi, 25 Nov 1936, *Marshall s.n.* (holotype: GH).

Harrisia serruliflora (Haw.) Lourteig, Bradea 5: 408. 1991. *Cereus serruliflorus* Haw., Philos. Mag. Ann. Chem. 113. 1830. **LECTOTYPE** (Lourteig 1991): **Haiti**. Cul-de-sac, Plumier illustration. Reproduced in Burman 1758, *Pl. Amer.* 8: tab. 195, fig. 1; in Hunt 1984, p. 60; and in Mottram 2002, p. 113.

Shrubs or small trees, with well-developed erect trunk to 1 m. Spines of distal areoles not much overlapping those of adjacent areoles, shorter than stem width, to 2.0 cm long and 0.5 mm thick, spines of basal areoles crowded and overlapping, to 5.5 cm long and 1.0 mm thick. Flowers 17–23 cm long. Pericarpel green. Hypanthium green to brownish green distally, scales light green to green, ovate-lanceolate. Mid-hypanthium scales 2.2–3.3 × 11.0–13.1 mm. Sepals greenish brown. Immature fruit green and strongly tuberculate, becoming ellipsoid, yellow, and strongly tuberculate near maturity. Mature fruit yellow, smooth, globose. Seeds 1.4–1.65 × 2.05 –2.6 mm. Figs. 8, 15, 66–73.

Distribution. Lowlands and coastal areas of Hispaniola (Fig. 3); scrub forest and scrubland; 5–400 m.

Specimens examined. **DOMINICAN REPUBLIC**. AZUA PROV.: Azua, *Rose et al. 3831* (GH, NY, US); Azua, *Lavastre 2207* (NY); Puerto Tortuguero y Hatillo, *García et al. 137* (JBSD); Hatillo, *Zanoni 31122* (JBSD, USF); Palmar de Ocoa, *Clase & García 2859* (JBSD); Hatillo, *Veloz 1779* (JBSD); Hatillo, *Franck et al. 2305* (USF); Hatillo, *Franck et al. 2306* (USF); Azua, *Lavastre 1914* (NY). BARAHONA PROV.: Las Salinas, *Fuertes 974* (NY); Valley of Neiba, *Howard & Howard 8336* (GH, NY, US). INDEPENDENCIA PROV.: Municipio La Descubierta, Las Caritas, *Clase et al. 5637* (JBSD); Duverge, *Camejo & Feliz 60* (JBSD). MONTE CRISTI PROV.: Villa Elisa, *Franck et al. 2309* (USF); Monte Cristi, *Franck et al. 2307* (USF); Monte Cristi, *Franck et al. 2308* (USF); Villa Elisa, *Sauleda et al. 7546* (USF); Guayubín, *Abbott 1016* (US). PERAVIA PROV.: Punta Caballera, *Zanoni et al. 22005* (JBSD); Baní, *Zanoni et al. 14970* (JBSD). PERDENALES PROV.: Perdenales, *Liogier & Liogier 25260* (JBSD); Cabo Rojo, *Veloz et al. 942* (JBSD); Cabo Rojo, *Zanoni & Mejía 16753* (JBSD, NY); El Guano, *Zanoni & Pimentel 25903* (JBSD); Cabo Rojo, *Fisher-Meerow 793b* (FLAS). SAN JUAN PROV.: San Juan de la Maguana, *Liogier & Liogier 26641* (JBSD); Guanito, *Sauleda et al. 7579* (USF). SANTIAGO PROV.: Santiago to Jacagua, *Liogier 11041* (GH, NY, US); Navarrete, May 1985, *Kimnach s.n.* (HNT); Santiago de los Caballeros, *Read 1076* (FTG). VALVERDE PROV.: Mao, *Abbott 1043* (US). **HAITI**. ARTIBONITE DEPT.: Gonaïves, *Clover 19396* (US); Gonaïves, *Clover 11015* (US). NORD-OUEST DEPT.: Port de Paix, *Ekman 3994* (K, NY, S, US); Port de Paix, *Leonard & Leonard 15642* (GH, NY, US); Baie des Moustiques, *Leonard & Leonard 12003* (K, US); Île de la Tortue, *Ekman 4165* (S). OUEST DEPT.: Étang Saumâtre, *Leonard 3513* (NY, US); Étang Saumâtre, *Leonard 4249* (NY, US); Plaine du Cul de Sac, 1916, *Buch s.n.* (IJ, illustration); Anse-à-Galets, *Leonard 3256* (US). SUD DEPT.: Port-à-Piment, *Ekman 700* (S).

Etymology. Divaricate branching.

Discussion. *Harrisia divaricata* often forms a well-defined trunk with spreading branches in the sub-canopy and often has a strongly tuberculate immature yellowing fruit (Figs. 69–70). It also has relatively small seeds and long spines on the basal parts of the stem. It has been suggested that *H. divaricata* is the only species in the Dominican Republic (Corman 2005). Generally, geography has been relied upon for identification, in that all specimens on Hispaniola would seemingly be *H. divaricata*. The spines of *H. divaricata* are not as densely overlapping as those of *H. portoricensis* and the mid-hypanthium scales may be longer in *H. divaricata*. These species may be sympatric and interbreed, as several specimens from Hispaniola match the densely spinose morphology of *H. portoricensis*. Britton & Rose (1920) distinguished *H. divaricata* (as *H. nashii*) as having "flower-buds pointed" compared to "flower-buds depressed truncate" in *H. portoricensis*. Additional study among living specimens across multiple populations would, of course, be ideal to assess these and other characters. *Harrisia fernowii* seems to have scales that are more ovate on the flower than those in *H. divaricata*, but additional study is warranted to clarify their morphological similarties and differences.

The flower bud shapes might be relatable to the fruit shape, which led Marshall (1941, 1943) to distinguish *Harrisia hurstii* with obovate fruits from *H. nashii* var. *straminea* with ellipsoid fruits, both at the same locality on Hispaniola. Both names proposed by Marshall seem to fall within the range of variation exhibited by *H. divaricata* and *H. portoricensis* (and here *H. hurstii* is tentavely synonymized with *H. portoricensis*). Immature fruits are often ellipsoidal in *H. divaricata*, and usually globose when mature. The variety proposed by Marshall (1941, 1943) was said to differ by having areoles with 11 straw-colored spines compared to *H. nashii* (=*H. divaricata*) having 3–6 gray spines per areole. Young spines are typically yellowish in ser. *Harrisia* of the West Indies and become gray upon maturity, and thus this character is not diagnostic. The number of spines per areole is quite variable within one plant, with some areoles on the type of *H. nashii* var. *straminea* having only six spines. *Harrisia divaricata*, *H. hurstii*, and *H. nashii* have all been recognized as distinct entities (Moscoso 1941, 1943; García et al. 2007), but it is unclear how these taxa were distinguished.

Britton & Rose (1920) doubted that Plumier's plate, one of the earliest known illustrations of a species of *Harrisia* (Burman 1758), could be referred to any cactus species and as such introduced the name *H. nashii*. The plate is undoubtedly a *Harrisia* (Hunt 1984) and *H. nashii* appears entirely synonymous with *H. divaricata* with regard to provenance and morphology. Mottram (2002) chose to narrow the lectotype of *H. divaricata* down to one particular drawing, since the two plates could represent different specimens or gatherings. Nonetheless, I have chosen to follow Lourteig (1991) in recognizing them as a single specimen, with one drawing showing the habit and the other showing finer details. The combination of both drawings helps to fix the application of the name to *H. divaricata*, showing the long spines on the trunk and the non-overlapping shorter spines on the younger stems. Lourteig (1991) proposed the combination *H. divaricata*, apparently unaware that Backeberg (1960) had already made the same combination.

14. Harrisia eriophora (Pfeiff.) Britton, Bull. Torrey Bot. Club 35: 562. 1908. *Cereus eriophorus* Pfeiff., Enum. Diagn. Cact. 94. 1837, nom. cons. prop. **NEOTYPE** (Benson 1982): **Cuba**. Pfeiffer & Otto, Abbild. Beschr. Cact., Tab. 22. 1843, typ. cons. prop.

Shrubs or small trees, with well-developed erect trunk to 1 m. Spines of distal areoles not overlapping those of adjacent areoles, shorter than stem width, to 2.0 cm long and 0.5 mm thick, spines of basal areoles crowded and overlapping, to 6.5 cm long and 1.0 mm thick. Flowers 16–23 cm long. Pericarpel green. Hypanthium green, scales green to green with red tips, ovate. Mid-hypanthium scales 2.8–3.2 × 7.7–10 mm. Sepals greenish pink. Immature fruit green, tuberculate. Mature fruit yellow, smooth. Seeds 1.7–2.1 × 2.6–3.35 mm. Figs. 74–80.

Distribution. West-central and western Cuba (Fig. 3); scrub forest and scrubland; 5–50 m.

Specimens examined. **CUBA**. *Wright 2623* (BM, G, GH, K, NY, P, S). ARTEMISA PROV.: Mariel, *León 13415* (GH, HAC). CIENFUEGOS PROV.: Cienfuegos, *Jack 5406, 5527, & 5556* (GH); Paso Caballos, *Wood, Jr. & Atchison 7446* (A); Jagua, *Carabia 18058* (HAC). HAVANA PROV.: Cojimar, *León 7179* (GH, HAC, NY); Cojimar, *Baker 2828* (US). ISLA DE LA JUVENTUD PROV.: Sierra de los Caballos, *Britton & Wilson 15122* (NY, US); Isle of Pines, s.d., *Jennings s.n.* (US, acc. no. 3045199). MATANZAS PROV.: Espada, *León 16111* (HAC). MAYABEQUE PROV.: Cruz del Norte, *León & Daniel 7802* (HAC, NY); Jibacoa, *León 16833* (HAC). PINAR DEL RÍO PROV.: Sierra Mendoza, *Shafer 11135* (NY); Pan de Azúcar, *E. del Riseo et al. 27580* (HAC); Remates de Guane, *Roig 3938, 4604* (HAC). SANCTI SPÍRITUS PROV.: Las Villas, *Shafer 12091* (A); Sancti Spíritus, *León 4091 & 4093* (HAC, NY); Sancti Spíritus, *Shafer 12090* (NY, US). VILLA CLARA PROV.: Coralillo, *Bermúdez 14270* (HAC).

Etymology. Woolly, for the flower buds (e.g. Braun 1992).

Discussion. *Harrisia eriophora* has flowers with relatively short scales and reddish sepals, relatively large seeds, and long spines on the basal parts of the stem. The designated neotype (typ. cons. prop., Franck 2016) may be from the type specimen, although it is in not absolutely certain.

Areces (1980) explained that red-tipped scales are found in southern Havana Prov. (now Mayabeque Prov.) and that plants along the northern coast have green scales without red tips (Britton & Rose 1920, plate 28; Figs. 74 and 80). However, plate 28 (Fig. 80) shows that the upper scales and sepals are reddish.

I have here identified the specimens of Charles Wright based on the length of the mid-hypanthium scales, which for the most part seems straightforward. However, this does not readily distinguish *Harrisia eriophora* and *H. taetra*, and so I am only guessing these specimens are more likely to be *H. eriophora*, as it is more widespread. The Wright specimens typically do not contain any information about their location within Cuba and the numbers on the specimens only represent a taxon number, not a duplicate specimen (Underwood 1905; Howard 1988). Indeed, nearly all the "2623" specimens of Wright appear to be *H. eriophora* (Fig. 79), with short mid-hypanthium scales, except for "2623" at US which is clearly *H. fernowii*. The specimens of Wright are some of the earliest known herbarium specimens of *Harrisia*, aside from the *H. gracilis* specimen of Abbé Daenen at G. The name *C. pellucidus* Pfeiff. (with five ribs in its protologue) may have been misapplied to *H. eriophora* if the *Wright* "2623" specimen seen by Grisebach (1866: 116) was *H. eriophora*.

Pfeiffer (1837) cited two earlier names in syonymy, causing *Harrisia eriophora* to be an illegitimate name that ought to have adopted the type of *C. cubensis*. It is currently being proposed that *Cereus eriophorus* be conserved and made legitimate since the epithet has been widely used ever since its introduction in 1837 (Franck 2016). However, to avoid *H. eriophora* itself being treated as another illegitimate name citing the earlier *C. cubensis* and not based on the basionym *C. eriophorus* (e.g. *Harrisia eriophora* Britton, nom. illeg.), Proposal 235 (Wiersema et al. 2016) would need to be accepted to allow for a conserved basionym to retroactively be available for the combination *H. eriophora* (Pfeiff.) Britton, with *C. cubensis* necessitating rejection. The neotype of *C. eriophorus* (typ. cons. prop.) was previously designated by Benson (1982: 934) and was overlooked by Franck (2012b) who superfluously designated the same neotype. This type must be conserved to preserve the modern use of *H. eriophora*. Greuter & Rankin (2016) opted to use the name *H. cubensis* for this taxon, though the protologue of the basionym *C. cubensis* is incongruent as it describes thick stems similar to tree-like species of *Cereus*, which in *Harrisia* are only found in *H. tetracantha*.

15. Harrisia fernowii Britton, Bull.Torrey Bot. Club 35: 562. 1908. **LECTOTYPE** (Franck 2014): **Cuba**. Santiago de Cuba Prov., Río Grande to Río Ubero, 1906, *Taylor 254* (NY [flower buds only]).

Harrisia taylorii Britton, Bull.Torrey Bot. Club 35: 565. 1908. *Cereus taylorii* (Britton) Vaupel, Monatsschr. Kakteenk. 23: 37. 1913. **LECTOTYPE** (Franck 2012b): Britton & Rose, The Cactaceae 2: 153, Fig. 224. 1920. **EPITYPE** (Franck 2012b): **Cuba**. Guantánamo Prov., Novaliches, *Hioram 1806* (NY, isoepitype: HAC).

Cereus eriophorus var. *laetevirens* Salm-Dyck ex Pfeiff., Enum. Diagn. Cact. 94. 1837. **NEOTYPE** (designated here): **Cuba**. Santiago de Cuba Prov., Río Grande to Río Ubero, 1906, *Taylor 254* (NY [flower buds only]).

Shrubs or small trees with well-developed erect trunk to 1 m. Spines of distal areoles sometimes overlapping those of adjacent areoles, sometimes longer than stem width, to 3.0 cm long and 0.5 mm thick, spines of basal areoles crowded and overlapping, to 7.5 cm long and 1.2 mm thick.

Flower length 19–23.5 cm. Pericarpel green. Hypanthium olive green to slightly reddish distally, scales green, ovate to ovate-lanceolate. Mid-hypanthium scales 3.2–4.8 × 12.8–18.0 mm. Sepals yellow green. Immature fruit green, moderately tuberculate. Mature fruit yellow, smooth, globose. Seeds 1.4–1.65 × 2.05–2.6 mm. Figs. 16, 81–86.

Distribution. East Cuba (Fig. 3); scrub forest and scrubland; 0–50 m.

Specimens examined. **CUBA**. *Wright 2623* (US); *Wright 2624* (BM, GH, K, P). CAMAGÜEY PROV.: entre Nuevitas y Minas, *León & Dahlgren 23393* (HAC). GRANMA PROV.: Sierra Maestra, *Meszaros 6* (ZSS), Cabo Cruz, *León 16358* (HAC). GUANTÁNAMO PROV.: Novaliches, *Maxon 4517* (NY, S, US); Guantánamo, *León 3931* (HAC, NY); Novaliches, *Britton 2003* (NY, US); Guantánamo Bay, *Britton 1969* (NY, US); Imías, *León & Pérez 12557* (HAC, NY, US); Imías, *León & Pérez 12484* (HAC, NY); Imías, *León 16854* (HAC); Novaliches, *Ekman 2962* (G, K, S); Pueblo de Maisí, *León 18495* (HAC); Maisí, *León 20097* (HAC). HOLGUÍN PROV.: Holguín, Jan 1984, *Dice s.n.* (HNT). SANTIAGO DE CUBA PROV.: Reuter, *León 3744* (HAC, NY); Daiquirí, *Britton & Cowell 12656* (NY); Santiago de Cuba, *León 3745* (HAC, NY); Santiago de Cuba, *Ekman 7752* (S); Bacanao, *Rauh 70007* (ZSS); Renté, *Chrysogone 2620* (HAC); Cabañas Bay, *Britton & Cowell 12814* (NY). U.S. NAVAL STATION GUANTANAMO BAY: Cuzco Beach, *Areces-Mallea et al. 6619* (MAPR).

Etymology. Bernhard E. Fernow (1851–1923), forester.

Discussion. The hypanthium and ovate-lanceolate scales of *Harrisia fernowii* are yellow-green to green. Its spines are much longer on the lower areoles of the stem, and its seeds are smaller than other species of *Harrisia* in Cuba. Here it is only marginally separated from *H. divaricata* by the flower scales; additional study is needed to clarify if they are distinct. The smaller seeds, longer hypanthium scales, and predominantly greenish flowers seem to distinguish *H. fernowii* from the putatively allopatric *H. eriophora*.

The description of *Harrisia fernowii* is stated to be mainly from *Taylor 254* (Britton 1908), though only a fragment packet of flower buds is extant and available as the lectotype (Franck 2014). Britton (1908) also identified a collection by Charles Wright in the protologue, but did not indicate which specimen was seen. It would presumably be the one at NY ("2623"), but based on the short hypanthium scales, this specimen is more likely *H. eriophora*. The numbers on Wright specimens are merely taxon numbers; specimens with the same number could have been collected at different times and places (Mill & Stark Schilling 2010). Wright's specimens are also bereft of specific locations within Cuba, but some knowledge of his whereabouts are known (Underwood 1905; Howard 1988). All the "2624" specimens appear to be *H. fernowii*. The earlier lectotype selected for *H. fernowii* (Franck 2012b) appears to be inappropriate since the specimen selected by Franck (2012b) is not cited in the protologue (Franck 2014).

The seed depicted in Barthlott & Hunt (2000: *Rauh 70007*) would presumably be *Harrisia fernowii*, not *H. eriophora* as stated in the text. The name *Cereus pitajaya* (Jacq.) DC has been misapplied to *H. fernowii* (Grisebach 1866: 116).

Cereus eriophorus var. *laetevirens* was described to have a yellow-green stem, and is possibly a synonym of *Harrisia fernowii*, whose stem is often light green (Britton 1908). It could be applied to other West Indian species of *Harrisia*. Although an old name, since it was described at the varietal level, it has no priority at the species level and is unlikely to be disruptive to the nomenclature of *Harrisia*. A neotype is designated to secure its application to *H. fernowii*.

The name *Harrisia undata* (Pfeiff.) Britton is illegitimate as the basionym is a later homonym for *Cereus undatus* Haw. (=*Hylocereus undatus* (Haw.) Britton & Rose). It is here supposed that

Harrisia undata, nom. illeg., was intended to represent the species here known as *H. fernowii* (Fig. 86).

16. Harrisia fragrans Small ex Britton & Rose, Cact. 2: 149. 1920. *Cereus fragrans* (Small ex Britton & Rose) Little, American Midland Naturalist 33: 496. 1945. *Cereus eriophorus* Pfeiff. var. *fragrans* (Small ex Britton & Rose) L. D. Benson, Cact. Succ. J. (Los Angeles) 41: 126. 1969. *Harrisia eriophora* (Pfeiff.) Britton var. *fragrans* (Small ex Britton & Rose) D. B. Ward, Novon 14: 366. 2004. **LECTOTYPE** (Franck 2012b): **USA**. Florida, St. Lucie Co., 6 mi. S of Ft. Pierce, hammock on sand dune, 20 Dec 1917, *Small 8457* (NY [00385810], isolectotypes: FLAS, GH, NY [00385809], S, US).

Harrisia simpsonii Small ex Britton & Rose, Cact. 2: 152. 1920. *Cereus gracilis* Mill. var. *simpsonii* (Small ex Britton & Rose) L. D. Benson, Cact. Succ. J. (Los Angeles) 41: 126. 1969. *Harrisia gracilis* (Mill.) Britton var. *simpsonii* (Small ex Britton & Rose) D. B. Ward, Novon 14: 367. 2004. **LECTOTYPE** (designated here): **USA**. Florida, Monroe Co., Pumpkin Key, collected by Small in 1916, flowered 18 Jun 1917 [43933] (NY, isolectotype: US [00174217]).

Shrubs, trunk not evident or poorly developed. Spines of distal areoles sometimes overlapping those of adjacent areoles, sometimes as thick as stem width, to 3.5 cm long and 0.8 mm thick, spines of distal and basal areoles similar. Flowers 15–20 cm long. Pericarpel red-green. Scales of mid-hypanthium 1.5–2.0 mm wide. Hypanthium red basally to brownish yellow-green distally, scales brownish yellow-green with red tips, deltoid-subulate. Mid-hypanthium scales 1.4–2.3 × 7.0–10.3 mm. Sepals brownish yellow-green to pale pink-brown. Immature fruit reddish green to dark red-purple, tuberculate. Mature fruit red to pale red to yellow-orange, smooth to lightly tuberculate. Seeds 1.7–2.0 × 2.7–3.0 mm. Figs. 4, 11, 14, 19, 36, 87–91.

Distribution. Atlantic Coast of peninsula, lower Everglades and Keys, Florida, USA (Fig. 3); coastal berm, scrub, shell mound, rockland hammock, and maritime hammock; 0–10 m.

Specimens examined. **USA.** FLORIDA: Between Indian River and ocean, *Curtiss 963* (NY, US). Brevard Co.: Malabar, 30 Jul 1912, *Small s.n.* (NY); Malabar, *Rolfs 78* (NY); Melbourne Beach, 7 Jan 1983, *Hames s.n.* (FLAS). Indian River Co.: Vero Beach, *Popenoe 2411* (FTG). Miami-Dade Co.: Madeira Hammock, 10 May 1919, *Small et al. s.n.* (NY); Cuthbert Lake, Apr 1916, *collector not given* (NY); Biscayne Bay, *Franck 1236, 1465, 2845, 2899* (USF). Monroe Co.: Pumpkin Key, 1919, *Small s.n.* (NY, US); Flamingo, May 1919, *Small s.n.* (NY); Key Largo, 22 May 1919, *Small & DeWinkeler s.n.* (NY); Key Largo, *Small 29964.* (NY); Cape Sable, *Moldenke 5861* (NY); Upper Matecumbe Key, *Moldenke 5832* (NY); Everglades National Park, *Hill 2948* (FTG, UNC); Key Largo, *Long et al. 1863* (USF); Key Largo, 23 Feb 1968, *Skinner & Weymouth s.n.* (FTG); Flamingo, 16 May 1965, *Craighead s.n.* (FTG); Everglades, 16 Apr 1965, *Craighead s.n.* (USF); Tavernier, *Franck 1278* (USF); Everglades National Park, *Franck 1277* (USF); Everglades National Park, *Benson 16578* (RSA); Plantation Key, *Franck 1279* (USF); Harry Harris Park, *Franck 2203, 2722* (USF); Key Largo, *Franck 2204* (USF); Key Largo, *Austin et al. 6880* (FTG); Key Largo, *Austin & Austin 6868* (FTG); Turkey Gobbler Key, *Austin et al. 6896* (FTG); Big Pine Key: 8–9 May 1919, *Small et al. s.n.* (NY, US); *Miller, Jr. 1713* (US); *Killip 41330* (US); *Killip 32033* (FLAS, K, US); *Killip 44348* (US); *Benson et al. 16575* (RSA); *Austin et al. 6942* (FTG), 1986, *Tabb s.n.* (FTG); *Franck 2627* (USF). Palm Beach Co.: *Avery 1920* (FLAS), *Avery 1893* (FTG). St. Lucie Co.: Ft. Pierce, Aug 1916, *Vosburg s.n.* (US); Savannas Preserve State Park, *Franck 472* (USF); Ft. Pierce, *Benson & Benson 15375* (RSA); S of Ft. Pierce, May 1919, *Dahlgren s.n.* (F); Stuart, *McCart 11289* (FLAS), Savannas Preserve State Park, *Bradley et al. 2426* (FTG). Volusia Co.: Cape Canaveral National Seashore, *Franck 473* (FTG, USF); Turtle Mound, *Norman 101* (RSA).

Etymology. Fragrant, pertaining to the flower.

Discussion . *Harrisia fragrans* is the northernmost representative of the genus. It is the only West Indian species of *Harrisia* with red fruit (Small 1932). Observations of yellowish fruits appear to be incipient in maturation and later change to red or orangeish (Austin 1984). The lower hypanthium and pericarpel of the flowers are reddish and the spines are not noticeably longer on the basal parts of the plant. In one population, pinkish petals were observed (Fig. 81B), the only occurrence known so far in *Harrisia*.

The name *Harrisia simpsonii* is here treated as a synonym of *H. fragrans*. The DNA sequence data and morphology support synonymization of *H. simpsonii* with *H. fragrans* (Franck 2012b; Franck 2013; Franck et al. 2013b). Current known extant populations suggest a large disjunction between northern and southern populations along the east coast of Florida, however, this may have not been true historically (Franck 2012b). Vouchers are here cited from Volusia through to Monroe Cos., with the exception of Martin and Broward Cos. The St. Lucie Co. population of *H. fragrans* experienced an introgression of the plastid haplotype from *H. aboriginum* (Franck et al. 2013b). Of the two Florida species, *H. fragrans* has received the most study, mainly the upper-central peninsula populations which were treated as distinct from *H. simpsonii* (Rae 1995; Rae & Ebert 2002; Hutchinson & Pazara 2004; Bradley & Hines 2007).

The cited holotype of *Harrisia simpsonii* has never been located, however two others were cited in the protologue (Britton & Rose 1920), a photograph (Fig. 223) and Pumpkin Key specimens cultivated by the New York Botanical Garden and Charles Deering. Benson (1969) designated a lectotype congruent with the locality of the cited type. This specimen was not cited but was presumably available to Britton at NY as the label appears to bear his handwriting. In a strict interpretation of Art. 9.12 (McNeill et al. 2012), it would seem that a cited specimen must be chosen as lectotype over an uncited specimen, which is done here, however peevish it may be for a name whose application is fairly sound.

The name *Harrisia brookii* has been misapplied to this species (Small 1913a, 1913b). Backeberg (1977) listed *H. deeringii* as 2 m tall from Pumpkin Key, Florida but did not validly publish it. It presumably represents a population of *H. fragrans*.

17. Harrisia gracilis (Mill.) Britton, Bull. Torrey Bot. Club 35: 563. 1908. *Cereus gracilis* Mill., Gard. dict., ed. 8. 1768. *Cactus gracilis* (Mill.) Weston, Bot. univ. 1: 33. 1770. **LECTOTYPE** (Franck 2012b): Trew, Pl. Select., Tab. 14. 1751.

Shrubs, or small trees, with well developed trunk to 1m. Spines not overlapping those of adjacent areoles, shorter than stem width, to 2.5(–3.5) cm long and 0.5 mm thick, distal and basal spines similar. Flowers 21 cm long. Pericarpel green. Hypanthium greenish brown, scales yellow-green to green, subulate. Mid-hypanthium scales 2.5–3.3 × 11.6–12.8 mm. Sepals pale greenish brown. Immature fruit green, moderately tuberculate. Mature fruit yellow, smooth. Seeds 1.3–1.6 × 2.1–2.3 mm. Figs. 7, 12, 18, 37, 92–104.

Distribution. Coastal southern Jamaica (Fig. 3); scrubland forest; 5-100 m.

Specimens examined. **JAMAICA**. CLARENDON PAR.: Salt Island, *Britton 3070* (NY); Harris Savannah, Dec 1998, *Douglas s.n.* (UCWI); Harris Savannah, *Franck 2661* (USF). ST. ANDREW PAR.: Palisadoes, *Franck et al. 2265* (IJ, USF); Palisadoes, *Asprey et al. 2422* (UCWI); Palisadoes, *West & Arnold 468* (FLAS); Sandy Gully, *Robertson 2333* (UCWI); Hope, *Harris 6946* (UCWI); Kingston and Gregory Park, *Maxon & Killip 335* (F, GH, NY, US); Kingston, *Britton 413* (NY); Port Henderson, *Higgins s.n.* (photo, NY!). ST. CATHERINE PAR.: Hellshire Hills, *Scott 288* (UCWI); Hellshire Hills, *duQuesnay 453* (UCWI); Hellshire Hills, s.d., *Fleming s.n.* (ZSS, acc. no.

AX 12819); Spanish Town, *Proctor 36874* (FTG). ST. ELIZABETH PAR.: Great Pedro Bay, *Britton 1255* (NY).

Etymology. Gracile, slender stems.

Discussion. *Harrisia gracilis* is the only short-spined species outside of Florida. It differs from the Florida species by having a greenish brown hypanthium (Britton 1917a) and smaller seeds. The name *C. eriophorus* had been misapplied to this species (Grisebach 1860). Some of the earliest known descriptions of *Harrisia* are of *H. gracilis* from Jamaica (Sloane 1696; Trew 1751). The earliest known specimen of *Harrisia* is also likely of this species from the herbarium of Abbé Daenen (Fig. 101), who published on the medicinal applications of plants (Daenen 1852). It is unknown when the specimen was made as only the date of reception at G is noted.

The name *Cereus repandus* (L.) Mill. is modernly applied to a thick-stemmed, tree-like cactus of *Cereus* s. str. (Hunt et al. 2006), though *Cereus repandus* sensu Haworth (1812) cited the lectotype and basionym of *Harrisia gracilis*. Haworth (1812: 183) provided the exact same Latin diagnosis of *Cereus repandus* as Linnaeus did for *Cactus repandus* L., but Haworth cited other elements. It seems Haworth (1812: 183, 1819: 78) was proposing that *Cactus repandus* L. and *Cereus gracilis* Mill. were synonymous. However, Miller had already published the name *Cereus repandus*, thus making Haworth's sense of *C. repandus* misapplied or a later homonym. Furthermore, Miller's *Cereus repandus* cited the now lectotype of *Cactus lanuginosus* L. (lectotypified by Zappi 1994: 145) as well as repeating the nearly exact corresponding phrase from Linnaeus (1737: 182, no. 7) and Royen (1740: 279, no. 5) associated with *Cactus languinosus*, not citing the same elements in the Linnaean *Cactus repandus*. For *Cereus lanuginosus* Mill., Miller cited the page before the Hermann lectotype. The name *Cereus lanuginosus* Mill. has not been regarded as a new combination from the basionym *Cactus lanuginosus* L. and *Cereus lanuginosus* was not cited in synonymy for *Pilosocereus lanuginosus* (L.) Byles & G.D. Rowley (=*Cactus lanuginosus* L.) by Zappi (1994). Miller's *Cereus repandus* is not a clear new combination from the basionym *Cactus repandus* L., especially considering *Cereus lanuginosus* Mill. is not treated as such. The combination and application of *Cereus repandus* (L.) Mill. are not at all straightforward (see Kiesling 1982; Heath 1992; Hunt & Taylor 1992) and the name is in need of typification and clarification. Perhaps it should just be considered that Miller made valid combinations of all Linnaean epithets of *Cactus* that he cited in 1768 under *Cereus* but made errors in doing so.

18. Harrisia portoricensis Britton, Bull.Torrey Bot. Club 35: 563. 1908. *Cereus portoricensis* (Britton) Urb., Symb. antill. 4: 430. 1910. **NEOTYPE** (Franck 2012b): **Puerto Rico**. mainland, near Ponce, 1906, *Britton & Cowell 1324*, flowered 21 Aug 1912 (NY). **EPITYPE** (Franck 2012b): **Puerto Rico**. Mona Island, 6 Mar 1994, *Areces-Mallea s.n.* (2 sheets, NY).

Harrisia hurstii W.T. Marshall, Cactaceae, with illustrated keys of all tribes, sub-tribes and genera, 96. 1941. **TYPE**: **Dominican Republic**. Monte Cristi Prov., Hurst finca near Monte Cristi, 25 Nov 1936, *Marshall s.n.* (holotype: GH).

Shrubs, trunk not evident or poorly developed. S pines of distal areoles usually overlapping those of adjacent areoles, often as long or longer than stem width, to 3.0 cm long and 0.7 mm thick, spines of basal areoles to 7.5 cm long, 1.0 mm thick. Flowers 17–22 cm long. Pericarpel green. Hypanthium green to greenish brown, scales yellow green to green, ovate-lanceolate. Mid-hypanthium scales 2.8–3.4 × 8.6–9.8 mm. Sepals pale greenish brown. Immature fruit green. Mature fruit yellow, smooth. Seeds 1.4–1.7 × 2–3 mm. Figs. 105–107.

Distribution. Southwest mainland and western and southern islands of Puerto Rico, and maybe west Dominican Republic (?) (Fig. 3); scrubland on exposed limestone rock; 0-150 m.

Specimens examined. **DOMINICAN REPUBLIC**(?). INDEPENDENCIA PROV.: Isla Cabritos, *Mejía & Pimentel 17228* (JBSD). MONTE CRISTI PROV.: El Morro, *Judd et al. 3002* (FLAS, JBSD); Monte Cristi, 25 Nov 1936, *Marshall s.n.* (GH). SANTIAGO PROV.: Jaiqui Picado, *Liogier 11241* (GH, NY, US). **PUERTO RICO**. *Britton 1957* (BM). PONCE MUNICIP.: Ponce to Playa Las Cucharas, *Britton et al. 1959* (NY, US); Caja de Muertos Island, *Breckon & López 7095* (MAPR). DESECHEO ISLAND: *Britton et al. 1599* (NY, US); *Woodbury et al. D-152* (MO, NY); *Breckon & Carraro 4780* (MAPR). MONA ISLAND: *Britton et al. 1737* (NY, US); *Chardon & Otero 1001* (NY); *Little, Jr. & Kuns 16540* (NY, US); s.d., *Fumero-Cabán & Meléndez-Ackerman s.n.* (USF, acc. no. 252611); *Breckon & Kolterman 6747* (MAPR). MONITO ISLAND: *Breckon et al. 5185* (MAPR). **CULTIVATED** (origin unknown) (?): *Peláez 1474* (JBSD).

Etymology. Puerto Rico.

Discussion. *Harrisia portoricensis* is here recognized by its densely overlapping and numerous spines in combination with its green scales and hypanthium. It is apparently extirpated from mainland Puerto Rico (Liogier 1994; Medina & Cuevas 2009) where it was found near Ponce (Britton 1908) and Guayanilla (Spencer 1955). The ecology of *H. portoricensis* in Puerto Rico has been extensively studied (Rojas-Sandoval & Meléndez-Ackerman 2013).

It would be easy and intuitive to state that *Harrisia portoricensis* is endemic to Puerto Rico, and this may indeed be the case. However, this assertion seems to presently rely solely on geography instead of demonstrated morphological differences. Based on the biogeography, it seems clear that populations from Hispaniola dispersed to give rise to the populations in Puerto Rico (Franck et al. 2013b), the easternmost extent of *Harrisia* in the West Indies. Several specimens cited here from coastal and dry limestone areas in the Dominican Republic match the densely spinose morphology of *H. portoricensis*. The length of the flower scales of these specimens is not known, which may differ between *H. divaricata* and *H. portoricensis*. Presently it is unclear if there is a proven morphological character that could define populations in Puerto Rico as endemic or if *H. portoricensis* should be regarded as present in the Dominican Republic. Britton & Rose (1920) claimed that Puerto Rican populations were distinct because of their depressed-truncate flower buds. Additional study is needed to verify or refute the geographic distribution of *H. portoricensis*.

The description given for *Harrisia hurstii* does not warrant recognition apart from *H. divaricata* and *H. portoricensis* based on current evidence. The holotype of *H. hurstii* seems to resemble *H. portoricensis*, given its strongly overlapping spines on the relatively thick stem. Apical stems of *H. portoricensis* often seem to be relatively thick, compared to *H. divaricata*, although slender stems can be observed on *H. portoricensis*, too. *Harrisia nashii* var. *straminea* (=*H. divaricata*) is seemingly from the exact same type locality as *H. hurstii*. Given that the two names proposed by Marshall (1941, 1943) have their provenance in the Dominican Republic, they may both be synonyms of *H. divaricata*, if *H. portoricensis* is proven to be endemic to Puerto Rico. *Harrisia hurstii* was distinguished as having "strict branches" and obovate fruits compared to the "divergent branches" and ellipsoid fruits of other nearby specimens in Monte Cristi Province, Dominican Republic. Photos are shown (Marshall 1941) to exemplify these characters, though they seem to depict rooted cuttings and not mature plants in habitat. The plants in the photo of the proposed *H. hurstii* (Marshall 1941: Fig. 46) do not appear to be old or tall enough to show any branching patterns. Though *H. divaricata* sometimes has divergent branches, ascendent branches are also observed. The branching angles of *H. divaricata* and *H. portoricensis* do not appear to be reliable characters for identification.

19. Harrisia taetra Areces, Revista Jard. Bot. Nac. Univ. Habana 1: 17. 1980. **TYPE: Cuba**. Pinar del Río Province, Peninsula de Guanahacabibes, Terraza, costera la Iguana, en la carretera al cabo de San Antonio, 27 Mar 1973, *Areces 37991* (holotype: HAJB).

Shrubs, trunk not evident or poorly developed. Spines of distal areoles usually overlapping those of adjacent areoles, often as long or longer than stem width, to 10.3 cm long and 0.9 mm thick, spines of basal areoles to 12 cm long, 1.5 mm thick. Flowers 16.5–20 cm long. Pericarpel pale green. Hypanthium vinaceous to rose-purple to rose-pink, sometimes reddish green distally, scales pale purple to yellowish with red tips, deltoid-ovate. Mid-hypanthium scales 2.8–3.0 × 5.4–7.8 mm. Sepals purple, slightly pinkish. Immature fruit greenish red to dark red-purple, moderately tuberculate. Mature fruit yellow, smooth to lightly tuberculate. Seeds 1.8–2.0 × 2.9–3.2 mm. Figs. 108–110.

Distribution. Southwest Pinar del Río Prov., Cuba (Fig. 3); scrubland on exposed limestone rock; 5–20 m.

Specimens examined. **CUBA**. PINAR DEL RÍO PROV.: Guanahacabibes, 17 Sep 2008, *ZSS staff s.n.* (ZSS); Corrientes Bay, *Britton & Cowell 9880* (NY); Península Corrientes, *Alain 6917* (HAC); Las Martinas, *Shafer 11096* (A, NY); Bay of Mariel, *Britton & Gager 7600* (K, NY, US).

Etymology. From *taeter*, meaning horrid, repulsive, etc. referring to the thick, spiny stems.

Discussion. *Harrisia taetra* has densely overlapping spines and flowers with red-purplish scales and a red-purplish hypanthium. Though apparently not very closely related, this species has a similar vegetative morphology to *H. portoricensis*, also occurring on exposed limestone rock and having densely overlapping spines. The distinctiveness of *H. taetra* from *H. eriophora* would benefit from further examination, as *H. eriophora* is apparently found nearby in Pinar del Río Province and on Isla de la Juventud.

NOTHOTAXA

×Guillauminara P.V. Heath, Calyx 1: 111. 1992. = *Echinopsis* Zucc. × *Harrisia* × *Trichocereus* (A. Berger) Riccob.

This is a hybrid allegedly between *Harrisia jusbertii* and *Trichocereus lamprochlorus* (Lem.) Britton & Rose, but this has not been verified.

×Harricereus G.D. Rowley, Natl. Cact. Succ. J. 37: 76. 1982. = *Cereus* Mill. × *Harrisia*.

Cereus and *Harrisia*, though both in tribe Cereeae, are in different subtribes (sensu Nyffeler & Eggli 2010) and the reported hybrid seems dubious. Ritter (1980) reported a natural hybrid between *H. bonplandii* and *C. stenogonus* K. Schum. in Puerto Casado, Paraguay.

×Harrisnopsis G.D. Rowley, Natl. Cact. Succ. J. 37: 77. 1982. ×*Eriocereopsis* Doweld, Tsukkulenty 4: 34. 2001. = *Echinopsis* × *Harrisia*. **TYPE**: ×*Harrisnopsis jusbertii* (Rebut ex K. Schum.) P.V. Heath.

It is claimed that *Harrisia jusbertii* is a hybrid of *Echinopsis* and *Harrisia* (Berger 1905), and hence there exists the name *Harrisnopsis*. There is currently no evidence, however, that any hybrid between these two genera has ever been made.

×Selenirisia G. D. Rowley, Natl. Cact. Succ. J. 37: 79. 1982. = *Harrisia* × *Selenicereus* (A. Berger) Britton & Rose.

This hybrid is allegedly between *Harrisia bonplandii* and *S. pteranthus* (Link ex A. Dietr.) Britton & Rose but as these two genera are distantly related across divergent tribes, it is extremely dubious. Their morphological similarity is probably the cause of misidentification.

EXCLUDED NAMES

Cereus bonplandii Parm. ex Pfeiff. var. *brevispinus* Maass-Zehlendorf, Monatsschr. Kakteenk. 15: 119. 1905, nom. nud.

Cereus bonplandii Parm. ex Pfeiff. var. *pomanensis* F.A.C. Weber ex K. Schum. Gesamtbeschr. Kakt. 137. 1899, nom. nud.

Cereus repandus Haw., Syn. Pl. Succ. 183. 1812, nom. illeg. [McNeill et al. 2012: Art. 53.1].

Cereus undatus Pfeiff., Enum. Diagn. Cact. 94. 1837, nom. illeg. *Harrisia undata* (Pfeiff.) Britton, Bull.Torrey Bot. Club 35: 564. 1908, nom. illeg. [McNeill et al. 2012: Art. 53.1].

Eriocereus (A. Berger) Riccob. subg. *Pseudoharrisia* Backeb., Blätt. Kakteenf. 1934–3, 1936–6. 1934–1936, nom. inval. [McNeill et al. 2012: Arts. 22.2 & 39.1]. This taxon ought to have been *Eriocereus* subg. *Eriocereus* since it included *H. tortuosa*.

Eriocereus (A. Berger) Riccob. subg. *Roseocereus* Backeb., Blätt. Kakteenf., 1934–3. 1934, nom. nud.

Eriocereus (A. Berger) Riccob. subg. *Roseocereus* Backeb., Blätt. Kakteenf., 1936–6: 5–6. 1936, nom. inval. [McNeill et al. 2012: Art. 39.1].

Eriocereus (A. Berger) Riccob. series *Acanthocarpi* Backeb., Blätt. Kakteenf. 1938–6. 1938, nom. nud.

Eriocereus (A. Berger) Riccob. series *Eriocarpi* Backeb., Blätt. Kakteenf. 1938–6. 1938, nom. nud.

Eriocereus cavendishii (Monv.) Riccob., Boll. Reale Orto Bot. Palermo 239. 1909. = *Monvillea cavendishii* (Monv.) Britton & Rose, Cact. 2: 21. 1920.

Eriocereus crucicentrus Ritter ex Backeb., Das Kakteenlexicon. 1966, nom. nud.

Eriocereus martianus (Zucc.) Riccob., Boll. Reale Orto Bot. Palermo 240. 1909. = *Disocactus martianus* (Zucc.) Barthlott, Bradleya 9: 88. 1991.

Eriocereus spinosissimus Buining & Brederoo. = *Arthrocereus spinosissimus* (Buining & Brederoo) F. Ritter, Kakteen in Südamerika 1: 244.

Estevesia P.J. Braun. Probably synonymous with *Cereus* or *Monvillea*.

Estevesia alex-bragae P.J.Braun & Esteves. Probably a species of *Cereus* or *Monvillea*.

Harrisia Lundblad, K. Svenska Vetensk. Akad. Handl. 4: 71. 1950, nom. illeg. [McNeill et al. 2012: Art. 53.1].

Harrisia Robineau-Desvoidy, Mem. Pres. Div. Sav. Acad. R. Sci. Inst. Fr. - Paris 2: 323. 1830, [kingdom Animalia, order Diptera].

Harrisia Britton [unranked] *Euharrisia* Britton & Rose, Cact. 2:148, nom. inval. [McNeill et al. 2012: Arts. 21.3 & 22.2].

Harrisia brailovskyi Carvalho, Rev. Bras. Bio. 43: 148. 1983, [kingdom Animalia, order Diptera].

Harrisia brasiliensis Robineau-Desvoidy, Mem. Pres. Div. Sav. Acad. R. Sci. Inst. Fr. - Paris 2: 324. 1830, [kingdom Animalia, order Diptera].

Harrisia deeringii Backeb., Das Kakteenlexicon. 1966, nom. inval.

Harrisia donae-antoniae M.L. Hooten, Cact. Succ. J. (Los Angeles) 63: 65. 1991 and Cact. Succ. Succ. J. (Los Angeles) 64: 2. 1992., nom. inval. [McNeill et al. 2012: Arts. 38.13 & 40.1].

Harrisia fimbriata (Lam.) F.M. Knuth, Kaktus-ABC 309. 1936. = *Stenocereus fimbriatus* (Lam.) Lourteig, Bradea 5: 408. 1991.

Harrisia fimbriata (Lam.) F.M. Knuth var. *straminia* W.T. Marshall, Cactaceae, with illustrated keys of all tribes, sub-tribes and genera, 96. 1941, nom. illeg. [McNeill et al. 2012: Art. 39.1].

Harrisia floridana Vosburg, nom. nud. Name on Vosburg's specimen at US.

Harrisia floridana Rose ex J.G. Webb, nom. nud. Name on Webb's specimen at NY.

Harrisia hahniana (Backeb.) Kimnach & Hutchison ex Kimnach, Cact. Succ. J. (Los Angeles) 59: 59. = *Echinopsis hahniana* (Backeb.) R. S. Wallace, Cactaceae Consensus Init. 4: 12. 1997.

Harrisia marsilioides Lundblad, K. Svenska Vetensk. Akad. Handl. 4: 71. 1950. = *Harrisiothecium marsilioides* (Lundblad) Lundblad, Taxon 10: 23. 1961.

Harrisia rumpalensis Moravec [Trilobita, publication details unknown, cited in Mergl, M., & P. Budil. 2010. Exceptional preservation of trilobite exoskeletons in the Řevnice Quartzite (Libeň Formation, Ordovician) from Ejpovice in the Rokycany area. Paleontologie 2010: 109–112.].

Harrisia scutellaris Robineau-Desvoidy, Mem. Pres. Div. Sav. Acad. R. Sci. Inst. Fr. - Paris 2: 324. 1830, [kingdom Animalia, order Diptera].

Harrisia tortuosa var. *uruguayensis* Osten, Notas sobre Cactáceas 66. 1941, nom. inval. [McNeill et al. 2012: Art. 39.1]. *Eriocereus pomanensis* var. *uruguayensis* (Osten) Backeb., Die Cactaceae 4: 2095. 1960, nom. inval. TYPE: Uruguay, Río Negro, Estancia Nueva Mehlem, en limo pampeano, 9 Apr 1922, *Schroeder s.n., Herb. Osten 16720* (MVM).

INCERTAE SEDIS

Cereus cubensis Zucc., Allg. Gartenzeitung 2: 244. 1834, nom. rej. prop. **TYPE**: **Cuba** (cultivated at Munich Botanical Garden).

Pfeiffer (1837) listed *Cereus cubensis* as a synonym of *C. eriophorus*. The description of *C. cubensis* described flowers like *C. grandiflorus* L. (= *Selenicereus grandiflorus* (L.) Britton & Rose), nocturnal, and stems thick like *C. peruvianus* (L.) Mill. As *Harrisia* in Cuba tends to have slender stems that are not distinctly thicker than *S. grandiflorus*, *C. cubensis* may refer to *Dendrocereus* Britton & Rose which has nocturnal flowers and thick stems. It has been proposed to reject the name *Cereus cubensis* since its usage, if applied to other Cuban cacti having names with a long history of use, is nomenclaturally disruptive. The protologue of *C. cubensis* is not sufficient to clearly apply it to any one taxon of cacti in Cuba and no original material is known (Franck 2016).

Cereus subrepandus Haw., Suppl. Pl. Succ. 78. 1819. *Eriocereus subrepandus* (Haw.) Riccob., Boll. Reale Orto Bot. Palermo 8: 243. 1909, nom. rej. prop. **TYPE**: Vigebat in hort. Chels. ante A.D. 1817.

This was said to be similar to *Harrisia gracilis* (as *C. repandus* Haw.) except with longer spines, possibly representing a taxon from Cuba or Hispaniola or simply slight variation consistent with *H. gracilis*. Riccobono (1909) mentioned a yellow fruit that is completely red at maturity, suggesting it to be *H. fragrans*, the only Caribbean species with red fruits. However, it is unclear what material Riccobono was examining as only the original material would seem to be relevant. *Cereus subrepandus* has been proposed for rejection since its description is too vague to clarify its application (Franck 2016).

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MONOGRAPH OF *HARRISIA* (CACTACEAE), PART 2, TABLES 1–2, FIGS. 1–19

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Table 1. Overview of taxonomy of *Harrisia*. cv = not known outside of cultivation

SUBGENUS	SECTION/SERIES		NO. OF SPECIES	INCLUDED SPECIES
Harrisia	sect. *Harrisia*	series *Harrisia*	10	*H. aboriginum, H. brookii, H. caymanensis, H. divaricata, H. eriophora, H. fernowii, H. fragrans, H. gracilis, H. portoricensis, H. taetra*
		series *Earlei*	1	*H. earlei*
	sect. *Adscendentes*		1	*H. adscendens*
Eriocereus	sect. *Eriocereus*		6	*H. bonplandii, H. jusbertii* (cv.), *H. martinii, H. pomanensis, H. regelii, H. tortuosa*
	sect. *Roseocereus*		1	*H. tetracantha*

Table 2. Number of species recognized in *Harrisia* by various authors, using the current infrageneric taxonomy.

	Britton & Rose (1920)	Backeberg (1977)	Anderson (2001)	Hunt et al. (2006)	This study
Series *Harrisia*	9	12	13	2	10
Series *Earlei*	1	1	1	0	1
Sect. *Adscendentes*	1	1	1	1	1
Sect. *Eriocereus*	5	6	4	5	6
Sect. *Roseocereus*	0	1	1	1	1

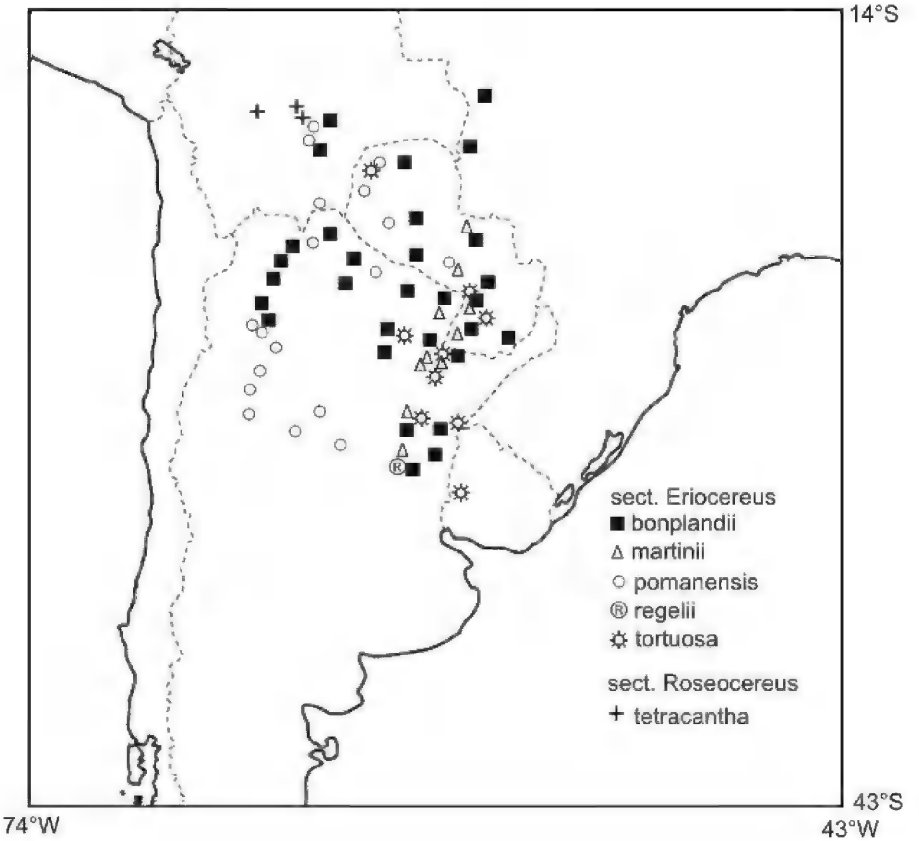

Figure 1. Map of distribution of *Harrisia* subg. *Eriocereus*. *Harrisia tetracantha* is stated to be present in Chuquisaca, Potosí, and Tarija Departments, Bolivia (Antezana & Navarro 2002) but no specimens were here examined. The distribution of *H. bonplandii* in Brazil is approximated from Eggli (2002).

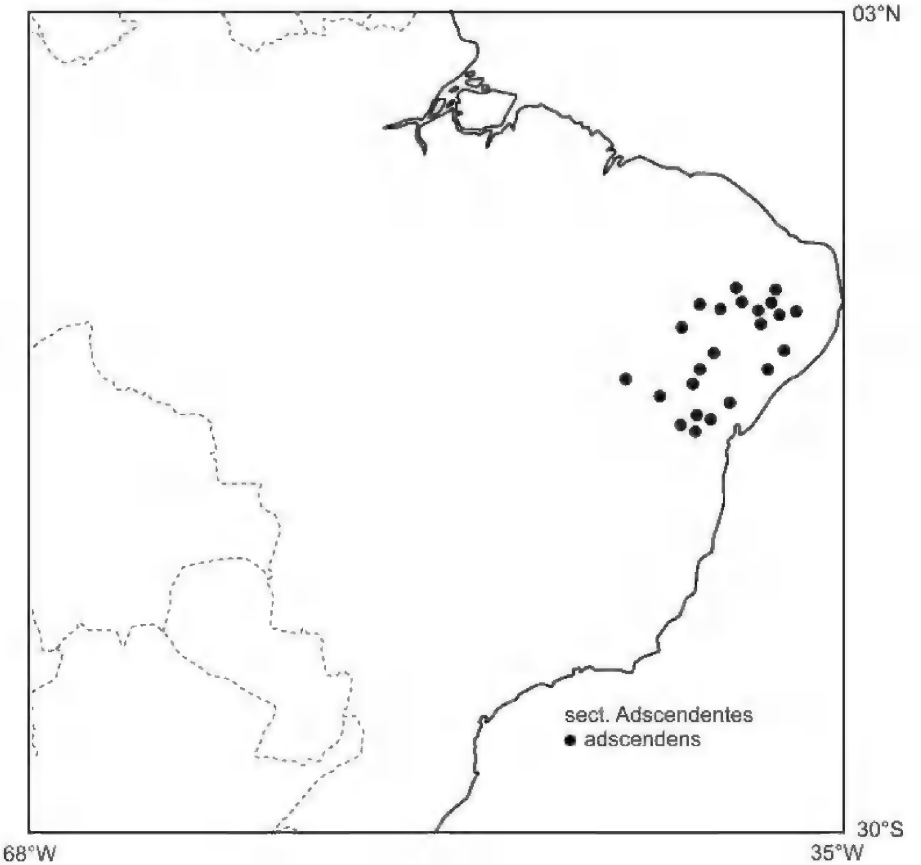

Figure 2. Map of distribution of *Harrisia adscendens*.

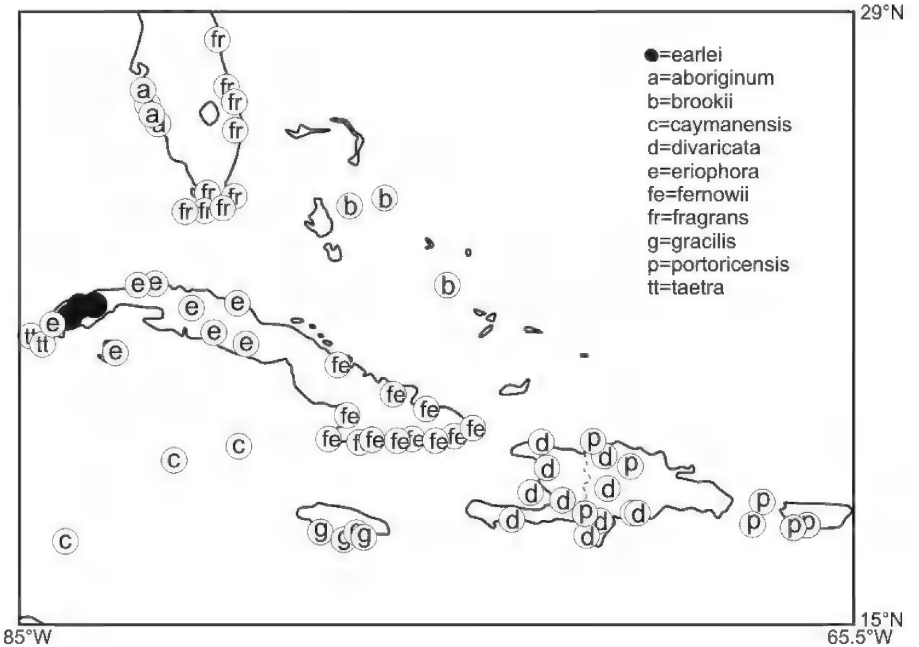

Figure 3. Map of distribution of *Harrisia* sect. *Harrisia*. Literature was also used for mapping *H. fernowii* (González Gutiérrez et al. 2006; Reyes & Acosta Cantillo 2007) and *H. divaricata* (Hilaire 2008). It is unclear if the "p" symbols denoting specimens morphologically similar to *H. portoricensis* in the Dominican Republic should be recognized as *H. divaricata* or *H. portoricensis*.

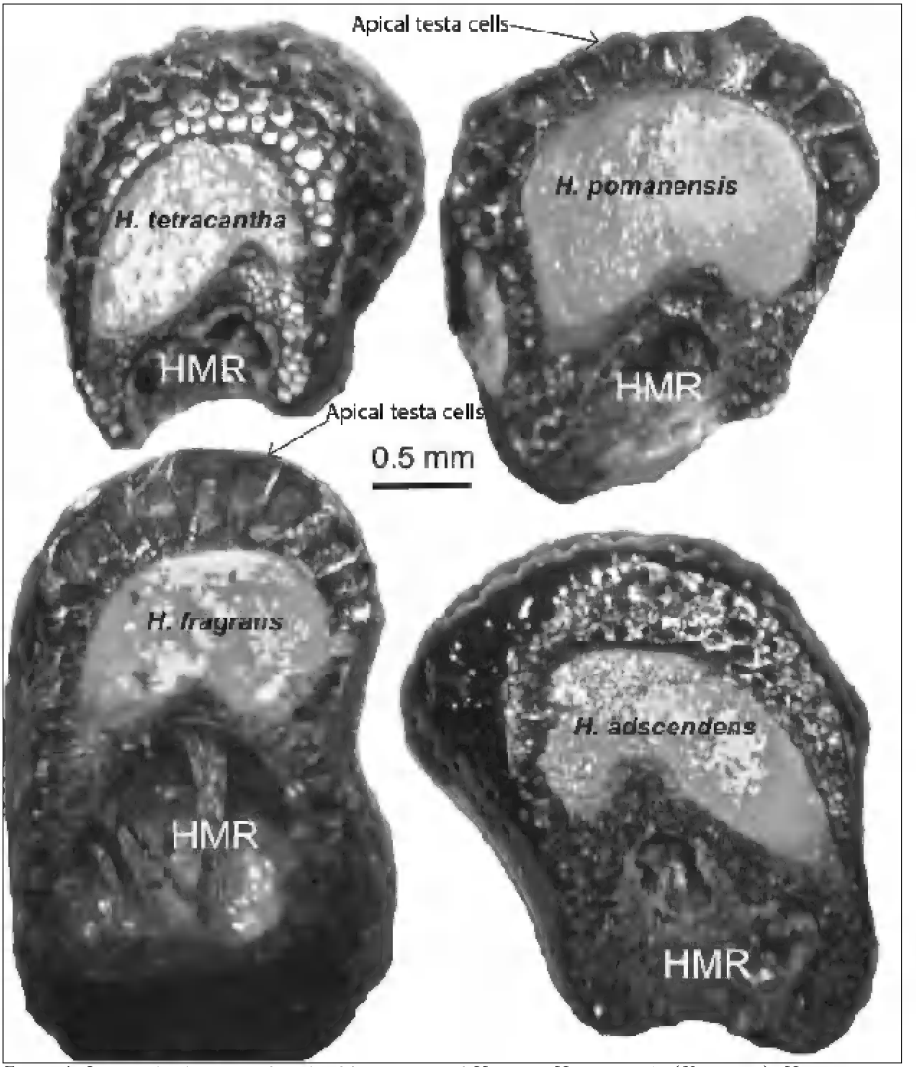

Figure 4. Longitudinal section of seeds of four species of *Harrisia*: *H. tetracantha* (*Kamm s.n.*), *H. pomanensis* (*Leuenberger & Eggli 4362*), *H. fragrans* (*Franck 472*), and *H. adscendens* (*Hofacker 403*). The cavernous hilum-micropylar region (HMR) is indicated. The row of hollow apical testa cells is plainly visible in *H. fragrans* and *H. pomanensis*. The grayish white interior of the seed contains endosperm and the embryo. Seeds were secured with cyanoacrylate, remnants of which are seen in the basal HMR of the seed of *H. pomanensis*.

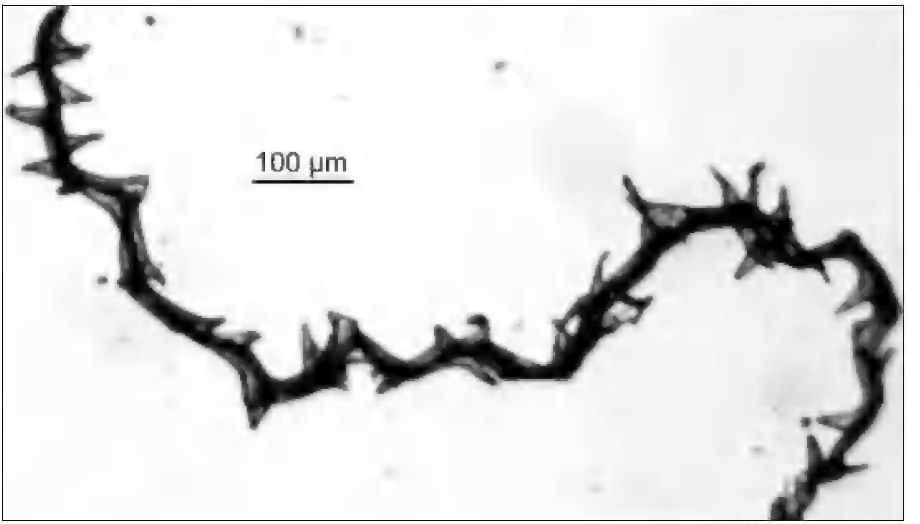

Figure 5. Light microscopy photo of scaly trichome from flower areole of *Harrisia regelii* (*Franck s.n.*, 19 Jun 2008).

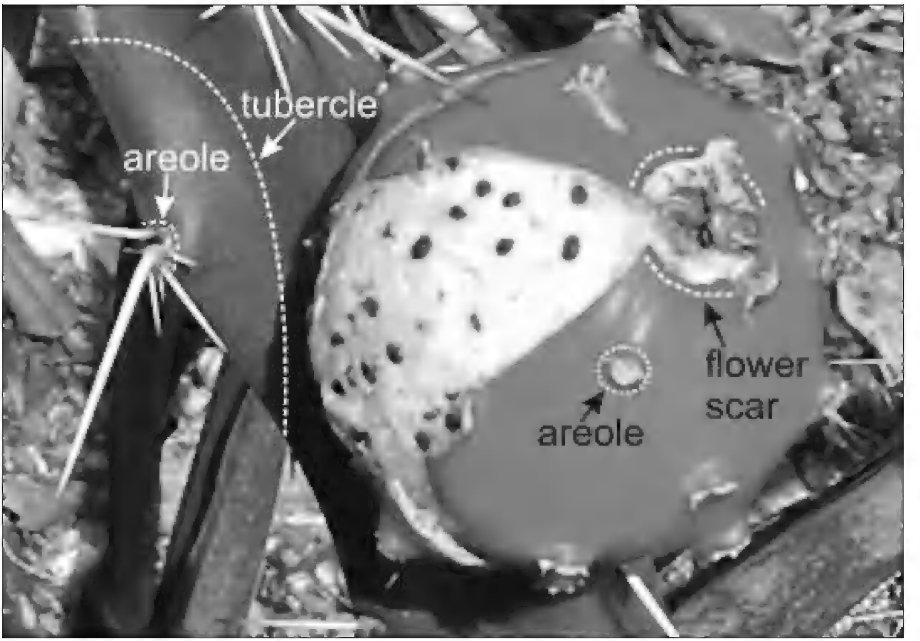

Figure 6. Photo of stem and splitting fruit of *Harrisia regelii* (*Franck 2662*), showing the areoles, flower scar, and stem tubercle. The fruit is ca. 4 cm in diameter.

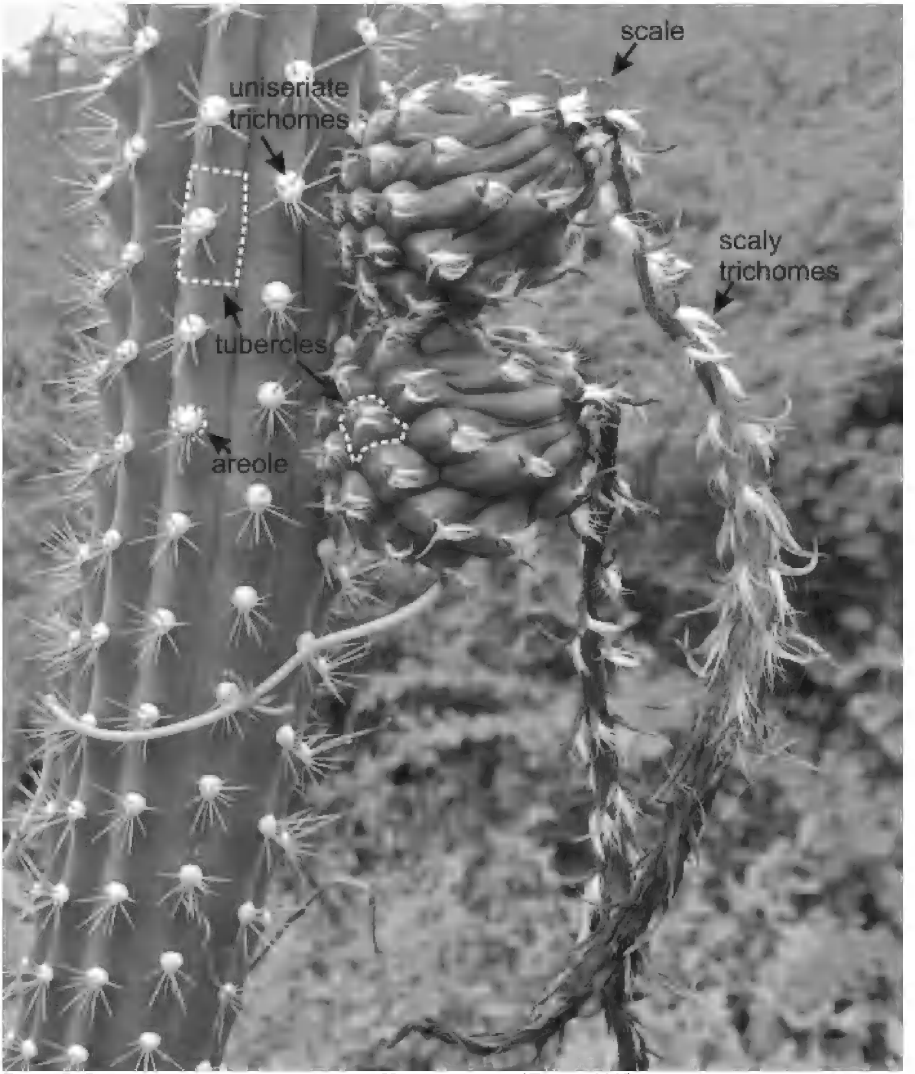

Figure 7. Photo of immature fruit and stem of *Harrisia gracilis* (*Franck 2265*), showing the areole, scale, tubercles, scaly trichomes, and uniseriate trichomes. The immature fruit is ca. 4 cm in diameter.

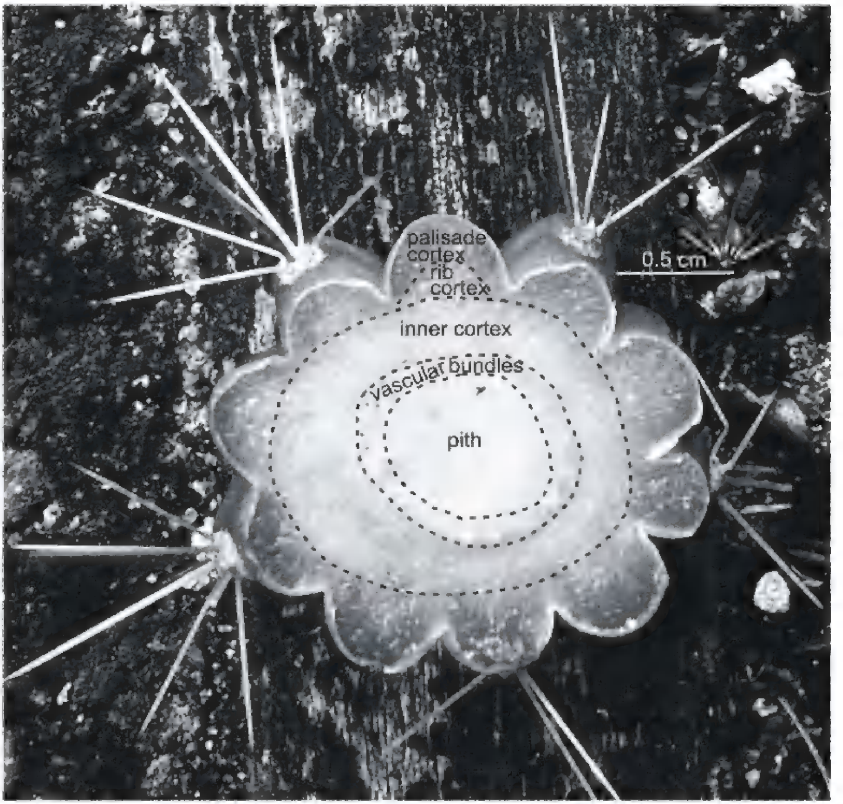

Figure 8. Cross-section of a 10-ribbed stem of *Harrisia divaricata* (*Franck 3021*), showing the palisade cortex, rib cortex, inner cortex, vascular bundles, and pith.

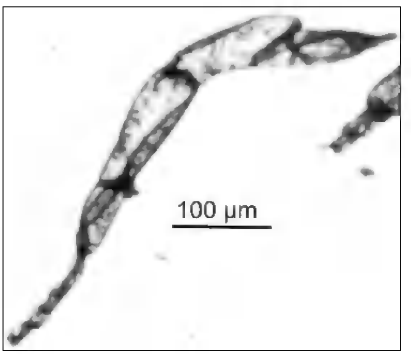

Figure 9. Light microscopy photo of uniseriate trichome from stem areole of *Harrisia adscendens* (*Franck 2641*).

Figure 10. Stem of *Harrisia* sect. *Harrisia*, showing the occasional presence of long, scaly trichomes on the areoles of young long-shoots.

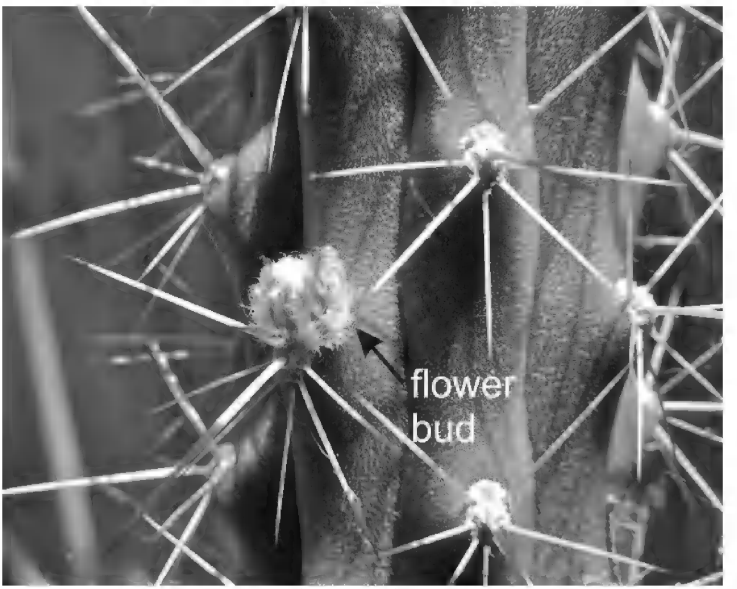

Figure 11. Photo of stem of *Harrisia fragrans* (*Franck 472*) showing the flower bud initiating from the adaxial portion of the areole. The diameter of the stem is ca. 3 cm.

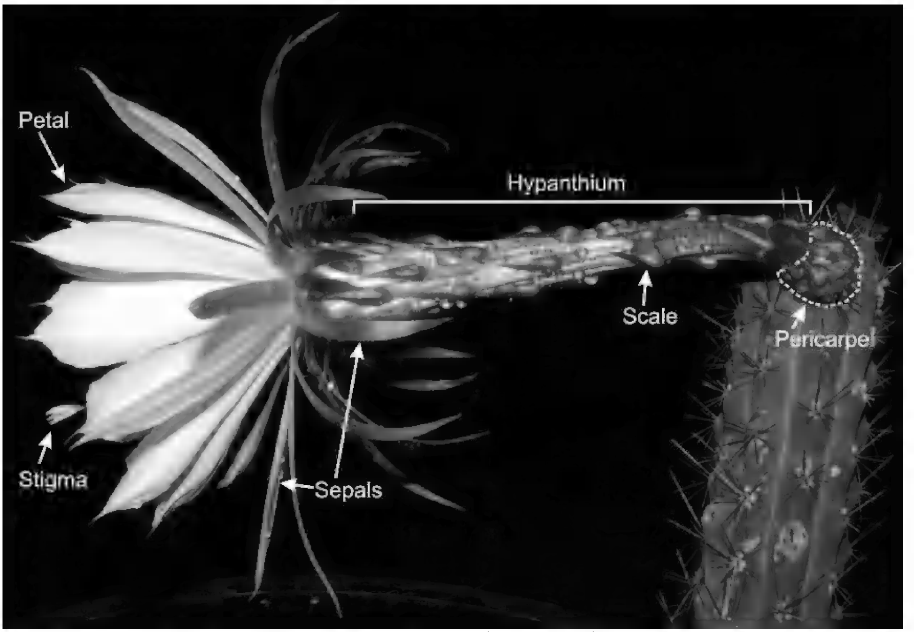

Figure 12. Photo of flower and stem of *Harrisia gracilis* (*Franck 2661*) showing the pericarpel, hypanthium, scales, sepals, petals, and exserted stigma. Water droplets are also visible on the hypanthium. The hypanthium is ca. 12 cm long.

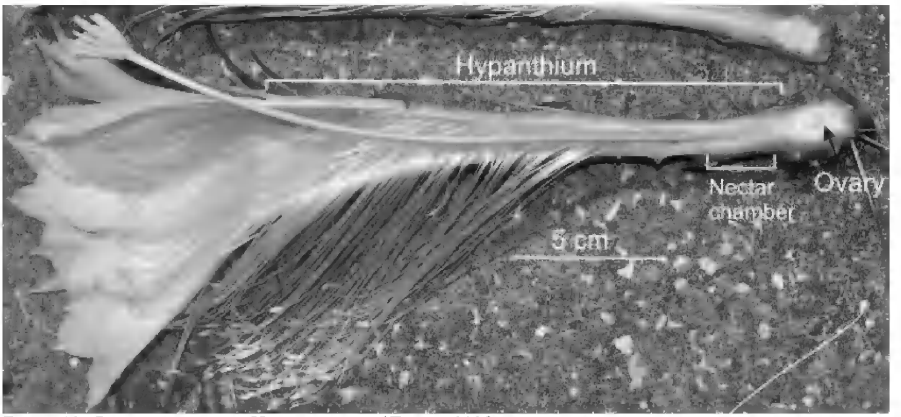

Figure 13. Photo of flower of *Harrisia regelii* (*Franck 3022*) showing the hypanthium, nectar chamber, and ovary. Each stamen of the dorsal stamen cluster arises independently from the inside of the hypanthium like the *Trichocereus*-type flower described by Schick (2011).

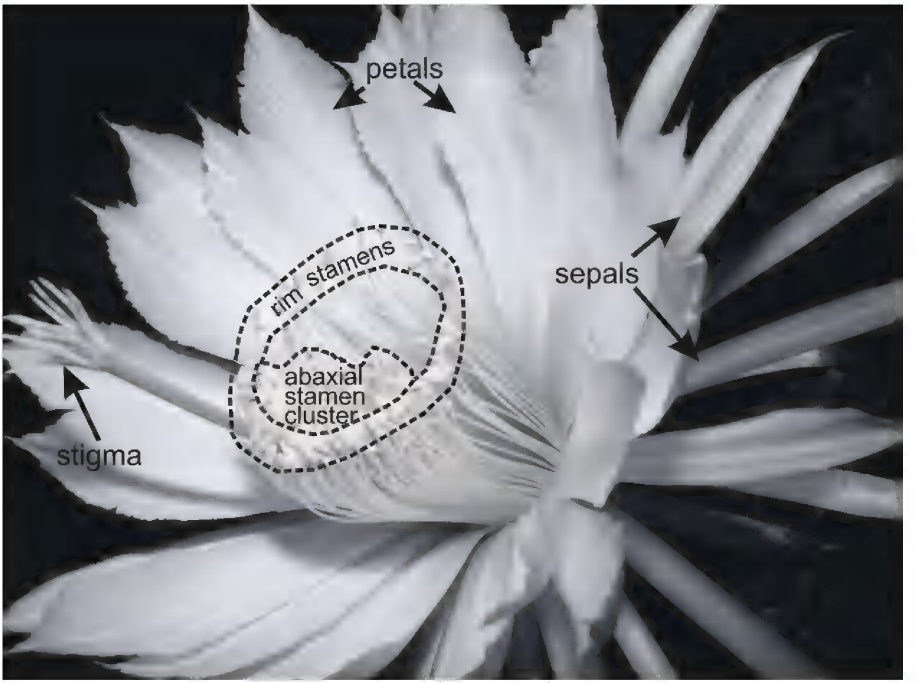

Figure 14. Photo of flower of *Harrisia fragrans* (*Franck 1236*) showing the abaxial stamen cluster, rim stamens, sepals, petals, and lobed stigma. The stigma lobes are ca. 8 mm long.

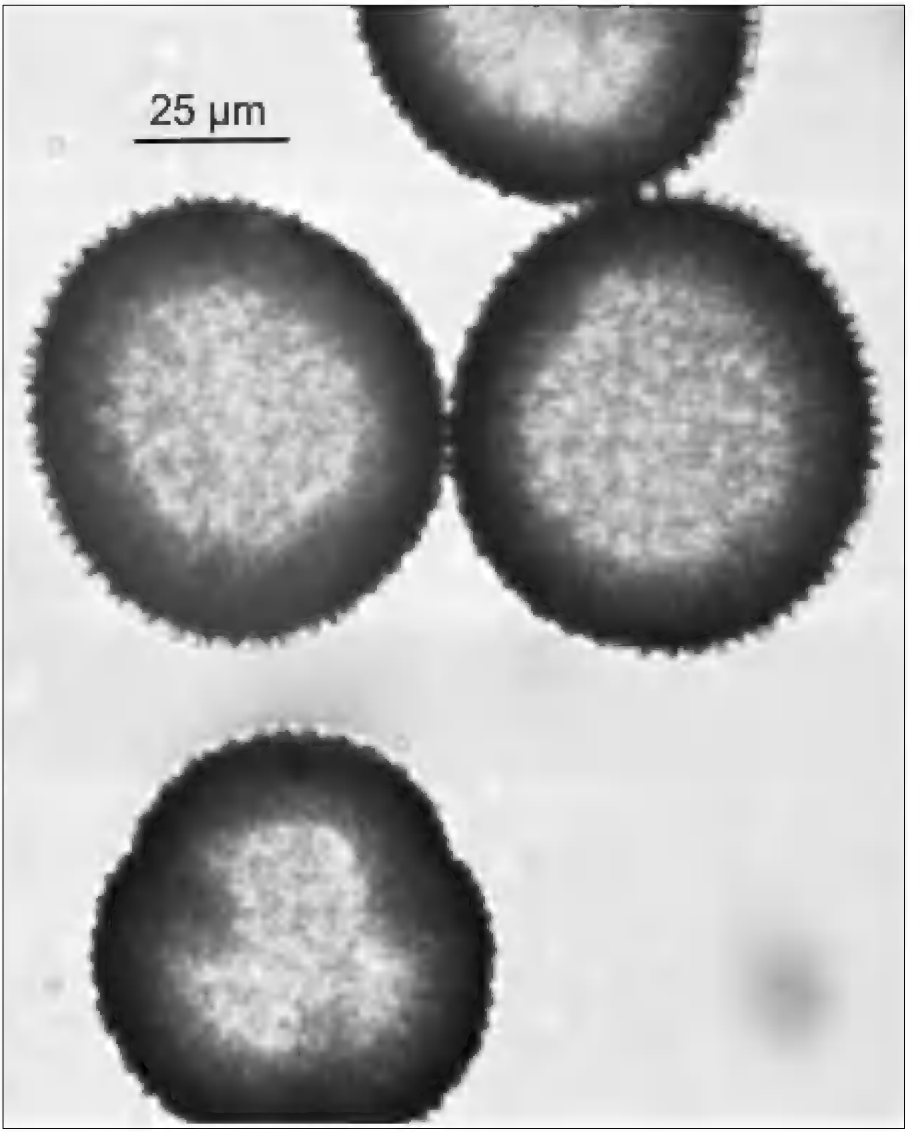

Figure 15. Light microscopy photo of unacetolyzed pollen of *Harrisia divaricata* (*Franck 3021*). Spinulae are evident at the outer circumference of the pollen.

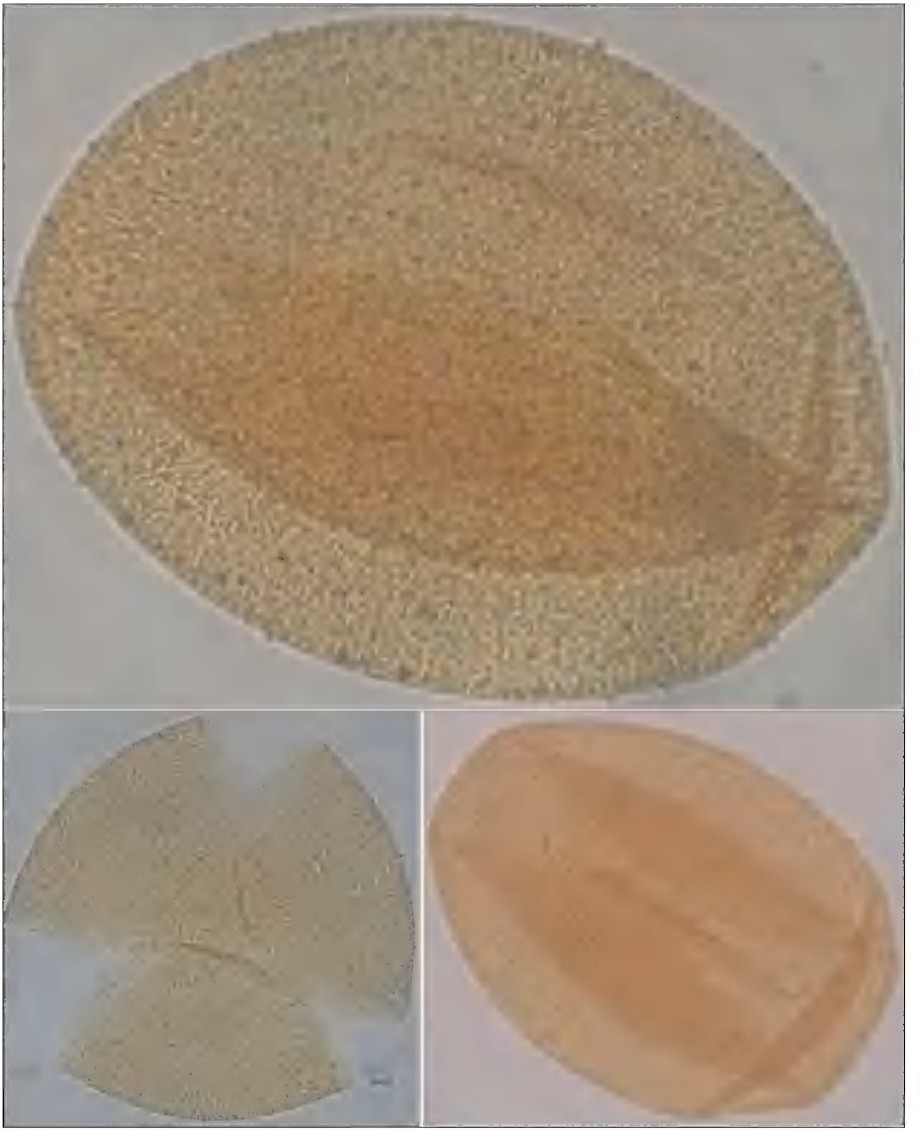

Figure 16. Light microscopy photo of acetolyzed pollen of *Harrisia fernowii* (unknown specimen as *H. taylorii*, probably from NY) from Bush & Weng (2007); top is equatorial view, bottom-left is polar view, and bottom right is aperture view.

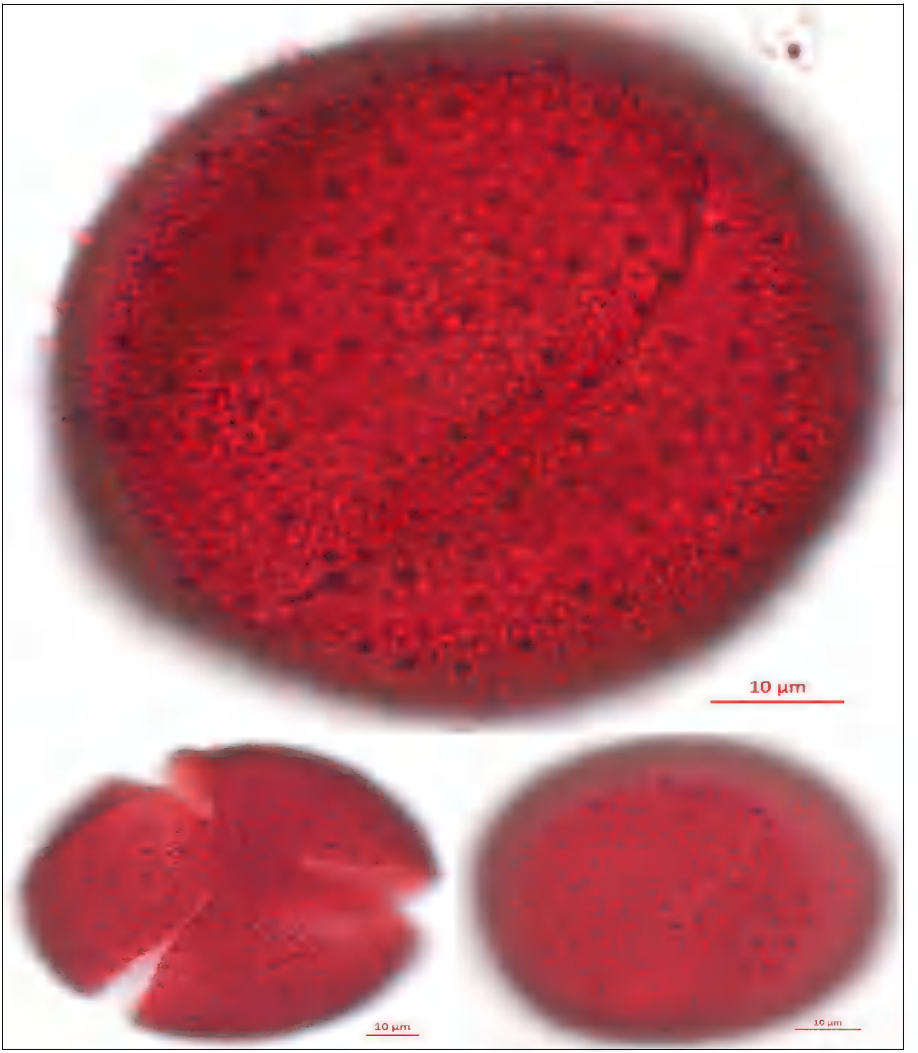

Figure 17. Light microscopy photo of acetolyzed pollen of *Harrisia martinii* stained with safranin-O from *Zardini & Tilleria 34496* (MO, acc. no. 5156682) from Bush & Weng (2007); top is equatorial view, bottom-left is polar view, and bottom right is aperture view.

Figure 18. Preparing *Harrisia gracilis* fruits for eating, Irish Town, Jamaica. In this instance, fresh limes were squeezed onto the fruit slices before eating.

Figure 19. A. Moth larva found feeding within immature fruit of *Harrisia fragrans* (*Franck 1278* (USF)). B. Germinating seed of *H. fragrans* within an old fruit, cultivated in Sarasota Co., Florida.

MONOGRAPH OF *HARRISIA* (CACTACEAE), PART 3, FIGS. 20–52

ALAN R. FRANCK, University of South Florida

Figure 20. *Harrisia tetracantha*, all by Michael Nee. A. Florida Prov., Santa Cruz Dept., Bolivia. B, E. Caballero Prov., Santa Cruz Dept., Bolivia. C, D. Vallegrande Prov., Santa Cruz Dept., Bolivia.

Figure 21. *Harrisia tetracantha*, all by Michael Nee. A. Vallegrande Prov., Santa Cruz Dept., Bolivia. B, C. Caballero Prov., Santa Cruz Dept., Bolivia.

Figure 22. *Harrisia tetracantha*, all by Michael Nee. A. Florida Prov., Santa Cruz Dept., Bolivia. B, C, D, E. Jardín Botánico de Cactáceas, Pulquina, Caballero Prov., Santa Cruz Dept., Bolivia. F. Caballero Prov., Santa Cruz Dept., Bolivia.

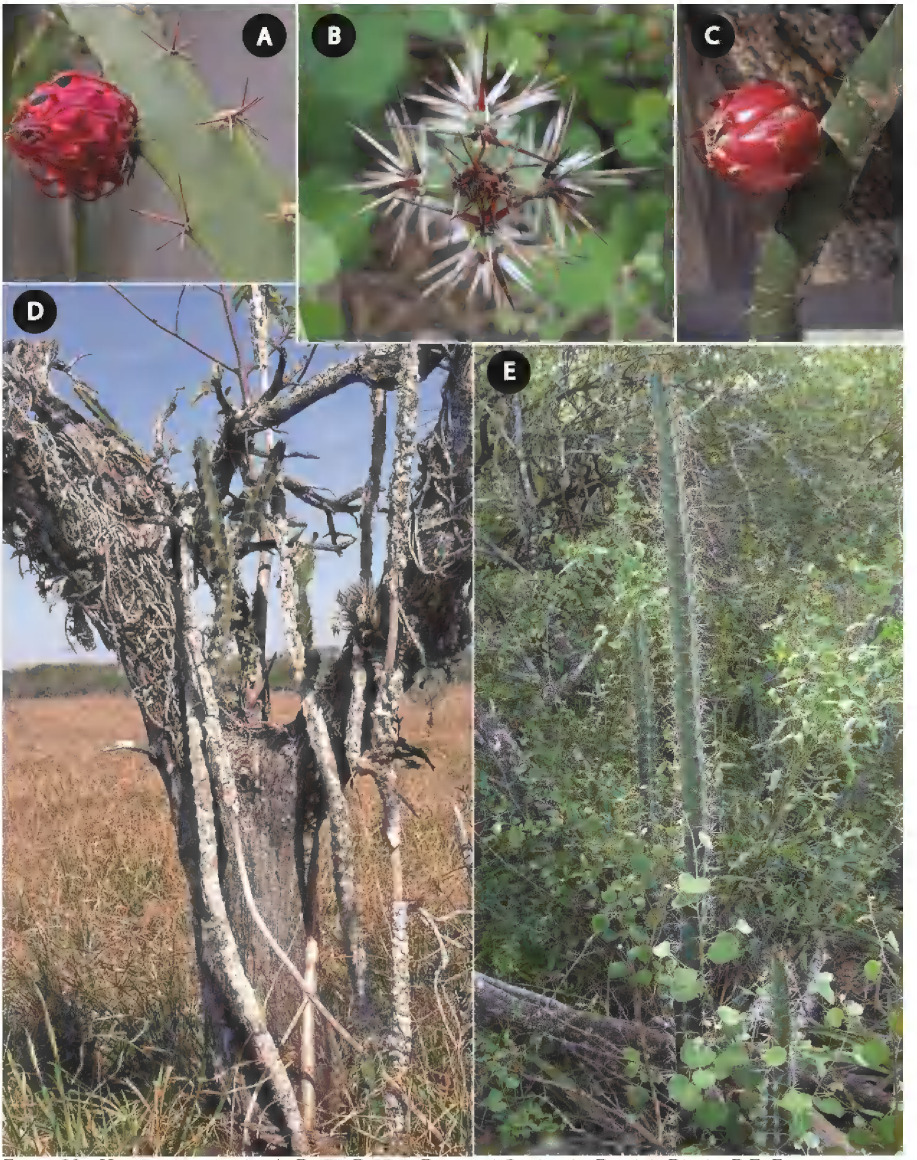

Figure 23. *Harrisia bonplandii*. A. Berlin-Dahlem Botanical Garden, by Ruud de Block. B,E. Formosa Province, Argentina, by Luis Jorge Oakley. C. In cultivation, by Roberto Kiesling. D. Corrientes Province, Argentina, by Roberto Kiesling.

Figure 24. *Harrisia bonplandii.* A,D. Boquerón Department, Paraguay, by Luis Jorge Oakley. B,C. Huntington Botanical Gardens, San Marino, California.

Figure 25. *Harrisia bonplandii.* All from South Africa, by Roberto Kiesling.

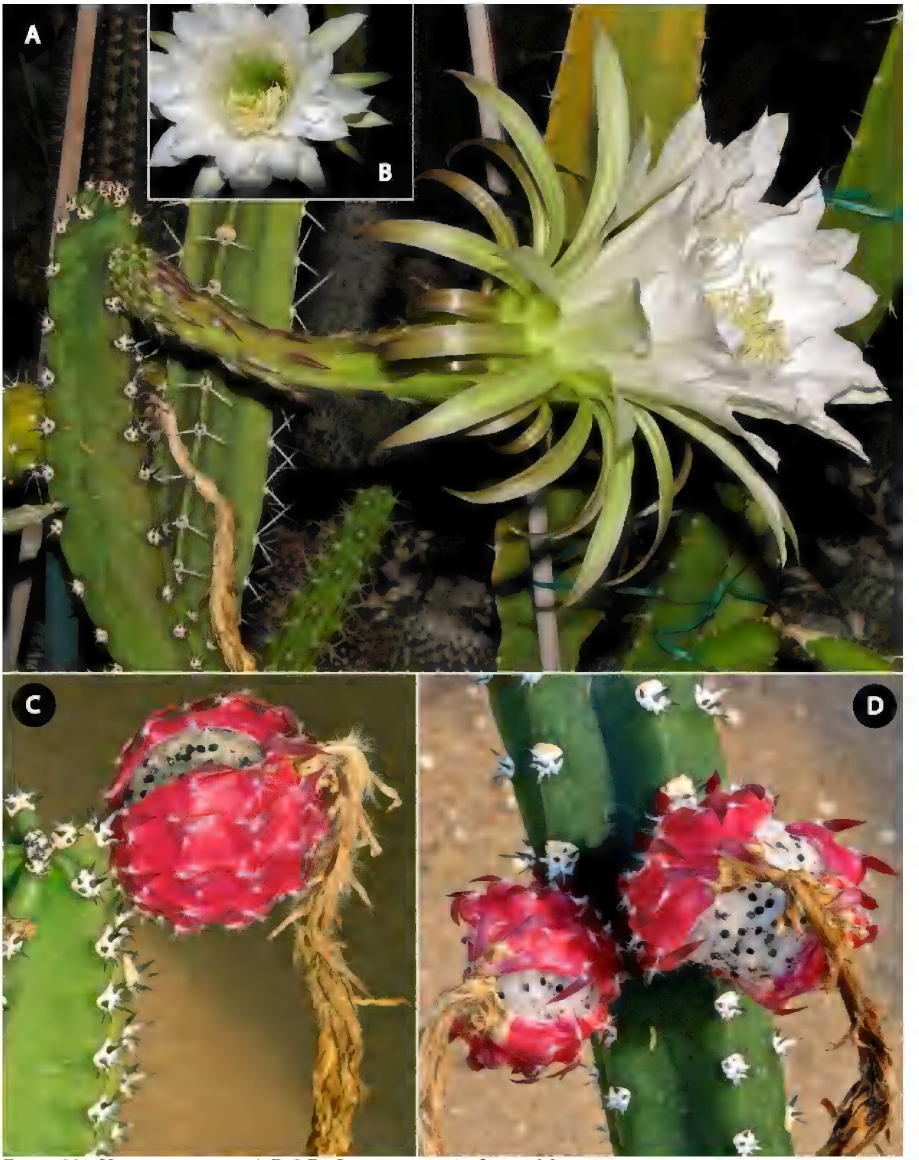

Figure 26. *Harrisia jusbertii.* A,B,C,D. In cultivation, by Jürgen Menzel.

CACTÉES

ANHALONIUM, Lem.

	FR.	C.
Prismaticum, Lem.....	5 à 18	»
Fissuratum. Engel....	10 à 20	»
Turbiniforme, W. s. Echinocactus Turbiniformis....	10	»
Williamsii, W, Echinocact..	4	»

CEREUS, Haw.

Acutangulus, Hort. Ber....	2	»
Alacriportanus, Hort. Mon.	1	50
Arcolatus.....	2	»
Azureus, Parm.....	1	»
Baumanni, Lem.....	1	»
Baxaniensis.....	1 à 2	»
Benecket, Ehr. s. Farinosus.	6	»
Bertini, Cels.....	4	»
Bomplandi, Parm.....	0	50
Brachiatus, syn. Hollianus.	1	50
Bridgesii, Salm.....	1	»
— *brevispinulus*....	2	»
Candicans.....	1	»
— *robustior*.....	1	50
— *Courantii*, Monv.	1	50
— *Dumesnilianus*.M.	2	»
Cauchini, Rebut, superbe.	5 à 10	»
Chalybæus, H B.....	1 à 2	»
Chilensis, Pfr.....	3	»
— *pycnacanthus*. S..	4	»
— *Quisco*.....	3	»
— *spinosissimus*....	5	»
Chiotilla, Web.....	3	»
Clavatus.....	3 à 5	»
Cærulescens, Salm.....	1	50
Cæsius, salm.....	1	50
Colubrinus, Otto.....	1	»
— *flavispinus*.....	1	»
Coryne, H. B	5	»
Deficiens, H. B	2 à 5	»
Donkelærii, Salm.....	1	50
Dumortieri, H. Belg.....	2 à 5	»
Dyckii, Mart.....	2	»
Eburneus, Salm.....	3	»
Emoryi, Engelm.....	2	50

	FR.	C.
Engelmanni.....	5	»
Eriophorus, Zucc.....	2	»
Euchlorus, Web	2	»
Euphorbioides, Haw.....	3	»
Farinosus, syn. Benekei....	6	»
Flagelliformis.....	0	50
— *cristatus*, Reb.	3	»
Forbesii, H. B.....	3 à 5	»
Formosus, Salm.....	1	»
— *monstruosus*..	1	50
Funckii, Forst.....	2	»
Gemmatus, Zucc.....	2	50
Geometrizans, Mart.....	1	50
Giganteus, Engelm	6	»
Grandiflorus, Haw.....	1	»
— *Maynardi*....	1	»
Greggii, Engel. s. *Pottsii*, S.	4	»
Gummosus, Eng. (nouveau).	4	»
Hankeanus, Web.....	2	»
Hæmaturicus, Web. (nouv.)	5	»
Heteromorphus, Monv.....	5	»
— *similis*....	5	»
Huascha flaviflorus, W. (n.)	3	»
— *rubiflorus*, W. (n.)	3	»
Intricatus.....	2	»
Isogonus, Hort. Germ	2	»
Jamacaru, Salm.....	1	50
— *cyaneus*, Cels...	1	50
— *glaucus*.....	1	50
Jacquini.....	2	»
Jusbertii, Rebut.....	5 à 10	»

Nouveauté très remarquable par ses aiguillons noirs, courts, semblables à ceux du cereus Palmeri.

Lamprochlorus, Lem.....	0	50
Lepidotus.....	2	»
Limensis, Salm.....	5	»
Linckii.....	3	»
Lutescens, Salm.....	1	50
Macrogonus, Hort. Ber.....	1	»
— *cristatus*.....	4	»
Malletianus, Cels.....	3	»
Marginatus, D. C.....	2	»
Martini, Lab.....	0	50

Figure 27. Page 3 of Rebut (1891?) containing the protologue of *Cereus jusbertii*.

Figure 28. Neotype of *Harrisia jusbertii* at HNT.

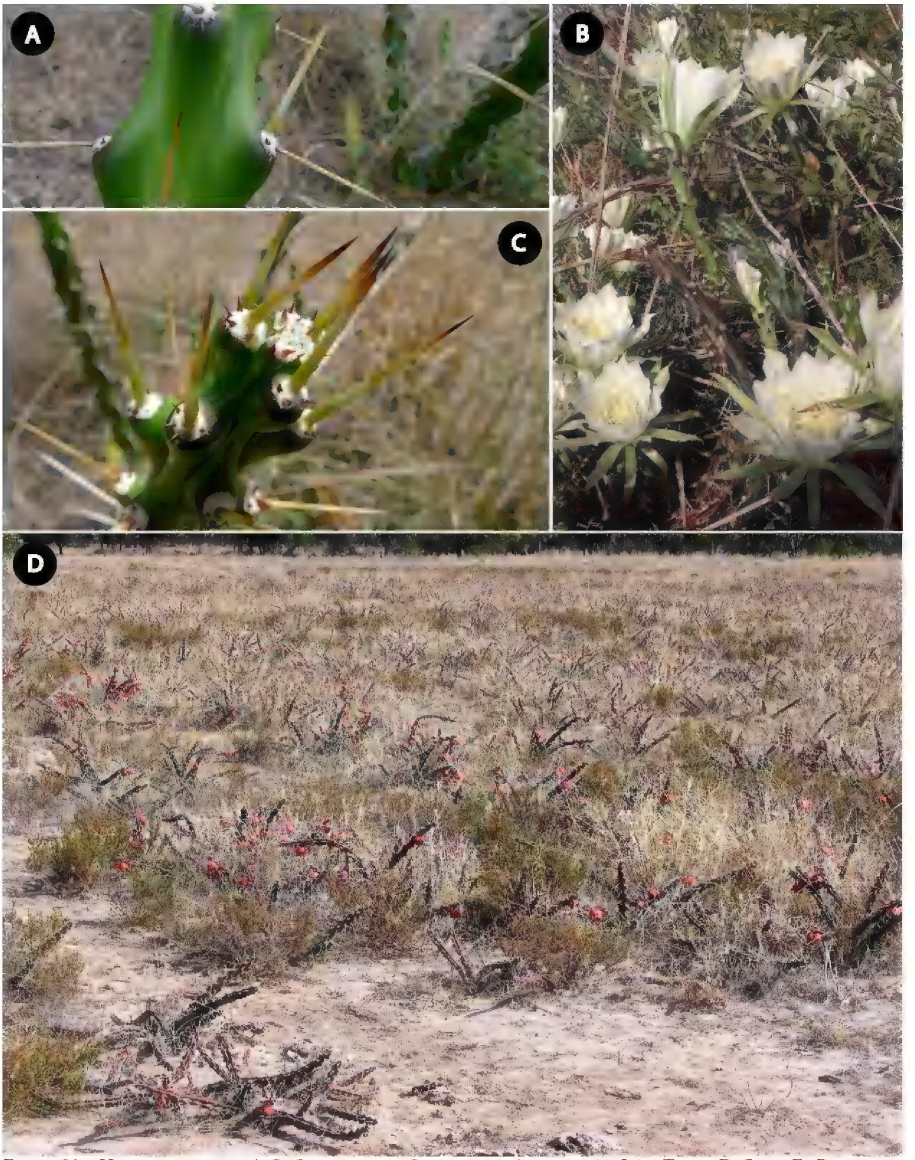

Figure 29. *Harrisia martinii*. A,C. Goondiwindi, Queensland, Australia, by John Tann. B. Santa Fe Province, Argentina, by Roberto Kiesling. D. Goondiwindi, Queensland, Australia, by Craig Hunter.

Figure 30. *Harrisia martinii*. A. Neotype clone in cultivation, by Roberto Kiesling. B. Formosa Province, Argentina, by Luis Jorge Oakley. C. Goondiwindi, Queensland, Australia, by John Tann.

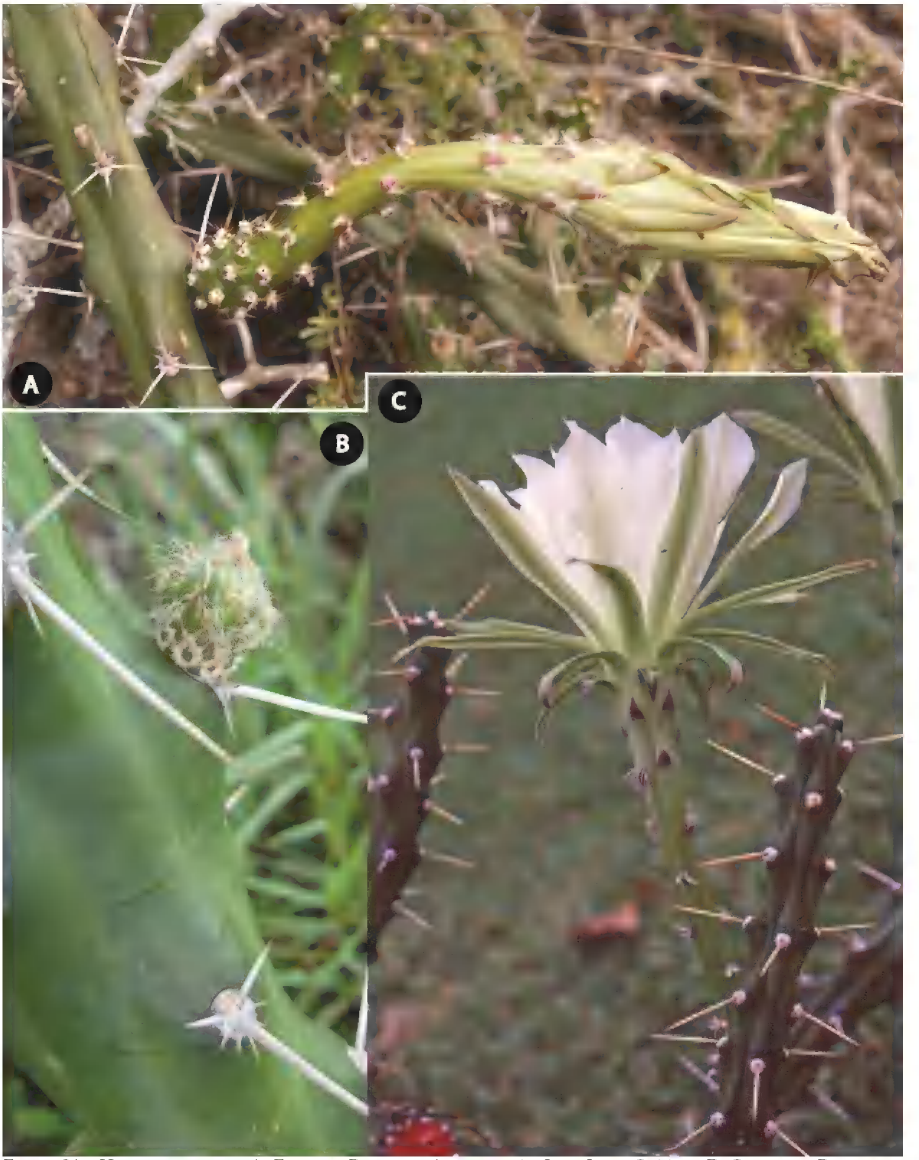

Figure 31. *Harrisia martinii*. A. Formosa Province, Argentina, by Luis Jorge Oakley. B. Corrientes Province, Argentina, by Luis Jorge Oakley. C. neotype clone in cultivation, by Roberto Kiesling.

Figure 32. *Harrisia martinii*. A. Corrientes Province, Argentina, by Luis Jorge Oakley. B. By Roberto Kiesling. C. Neotype clone in cultivation, by Roberto Kiesling.

Figure 33. *Harrisia martinii*. All from South Africa, by Roberto Kiesling.

Figure 34. *Harrisia martinii* (Berger 1905, plate 10, figs. 1–2, as *Cereus martinii*), and *Harrisia* cf. *bonplandii* (Berger 1905, plate 10, figs. 3–4, as *C. bonplandii*), both from La Mortola, Italy (Berger 1905).

Figure 35. *Harrisia martinii*, plate 68 (Britton 1917b) depicted from a plant at the New York Botanical Garden that was given by F.S. Curtis in 1897.

Figure 36. *Harrisia martinii* , plate 19, fig. 3 only (Britton & Rose 1920), illustrated by Mary E. Eaton. Also with *Harrisia fragrans* , plate 19, figs. 1–2 only (Britton & Rose 1920), depicting a plant originally from Malabar, Brevard County, Florida.

BRITTON AND ROSE, VOL. II
PLATE XX
M. E. Eaton del.
1. Part of fruiting branch of Harrisia gracilis.
2. Top of flowering branch of Harrisia martinii.
(Natural size.)

Figure 37. *Harrisia martinii*, plate 20, fig. 2 only (Britton & Rose 1920), illustrated by Mary E. Eaton. Also with *Harrisia gracilis*, plate 20, fig. 1 only (Britton & Rose 1920).

Figure 38. *Harrisia pomanensis*. A. Catamarca Province, Argentina, by Roberto Kiesling. B. By Michael Nee.

Figure 39. *Harrisia pomanensis.* La Rioja Province, Argentina, by Roberto Kiesling.

Figure 40. *Harrisia pomanensis.* A,B. Gran Chaco Prov., Tarija Dept., Bolivia, by Michael Nee.

Figure 41. *Harrisia pomanensis*. A,F. Catamarca Province, Argentina, by Roberto Kiesling. B. Gran Chaco Prov., Tarija Dept., Bolivia, by Michale Nee. D. by Michale Nee. C. By Bárbara Ruthzats. E. Cruz del Eje, Córdoba Province, by Joël Lodé.

Figure 42. *Harrisia pomanensis.* All from South Africa, by Roberto Kiesling. The top-right photo shows "witch's brooming" with several shoots coming from one area.

Figure 43. *Harrisia regelii.* A,B. Diamante Department, Entre Ríos Province, Argentina, by Roberto Kiesling.

Figure 44. *Harrisia regelii.* A,B,C,D,E. Cultivated in Sarasota Co., Florida, USA.

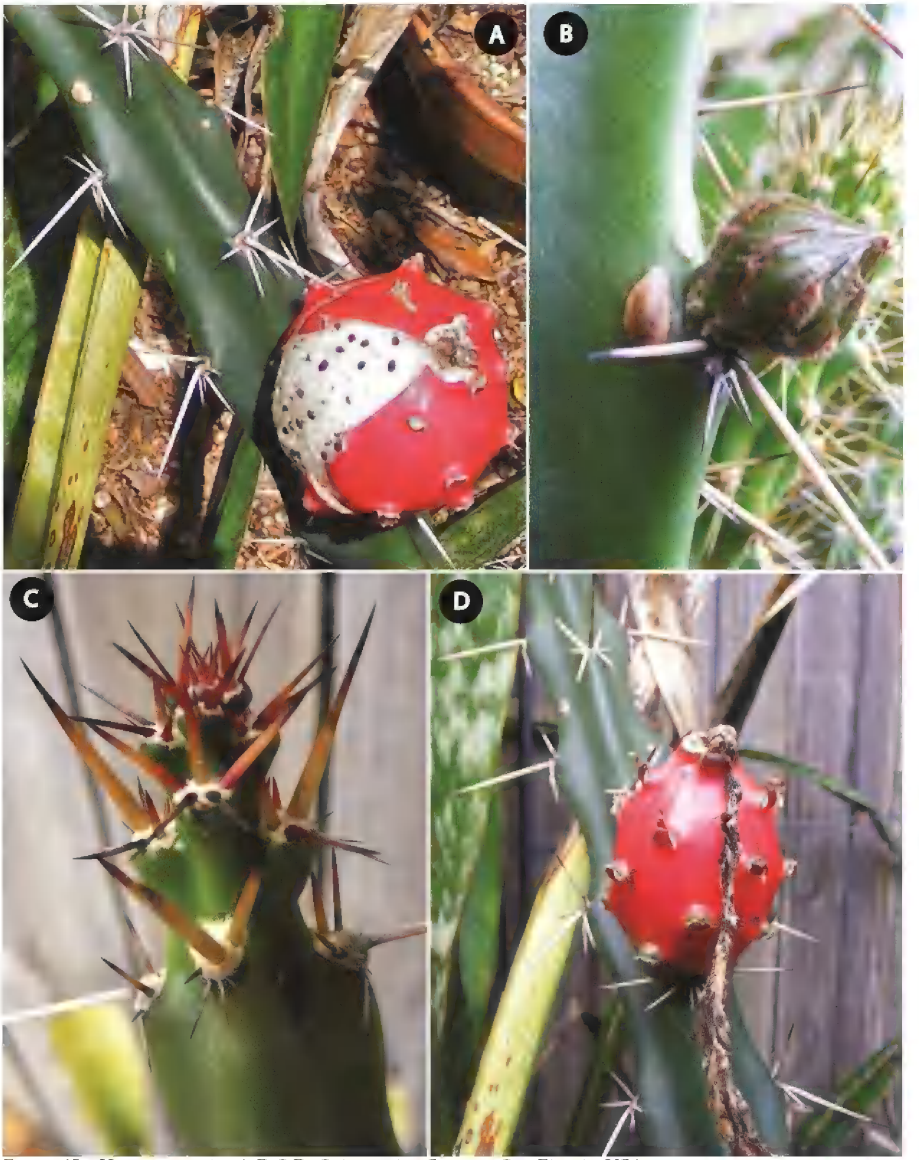

Figure 45. *Harrisia regelii.* A,B,C,D. Cultivated in Sarasota Co., Florida, USA.

Figure 46. *Harrisia tortuosa*. A. Santa Fe Province, Argentina, by Roberto Kiesling. B,C,D. Cultivated in Sarasota Co., Florida, USA.

Figure 47. *Harrisia tortuosa*. All from South Africa, by Roberto Kiesling.

Figure 48. *Harrisia tortuosa,* plate 9, fig. 1 only (Berger 1905), from La Mortola, Italy

Figure 49. *Harrisia tortuosa*, plate 21 (Britton & Rose 1920), illustrated by Mary E. Eaton.

Figure 50. *Harrisia adscendens.* A. By Joël Lodé. B. by Roberto Kiesling. C. Pernambuco, Brazil, by Roberto Kiesling.

Figure 51. *Harrisia adscendens.* In cultivation, by Joël Lodé.

Figure 52. *Harrisia adscendens*. Verdejante Municipal, Pernambuco, Brazil, by José Alves de Siqueira Fihlo.

MONOGRAPH OF *HARRISIA* (CACTACEAE), PART 4, FIGS. 53–86

ALAN R. FRANCK, University of South Florida

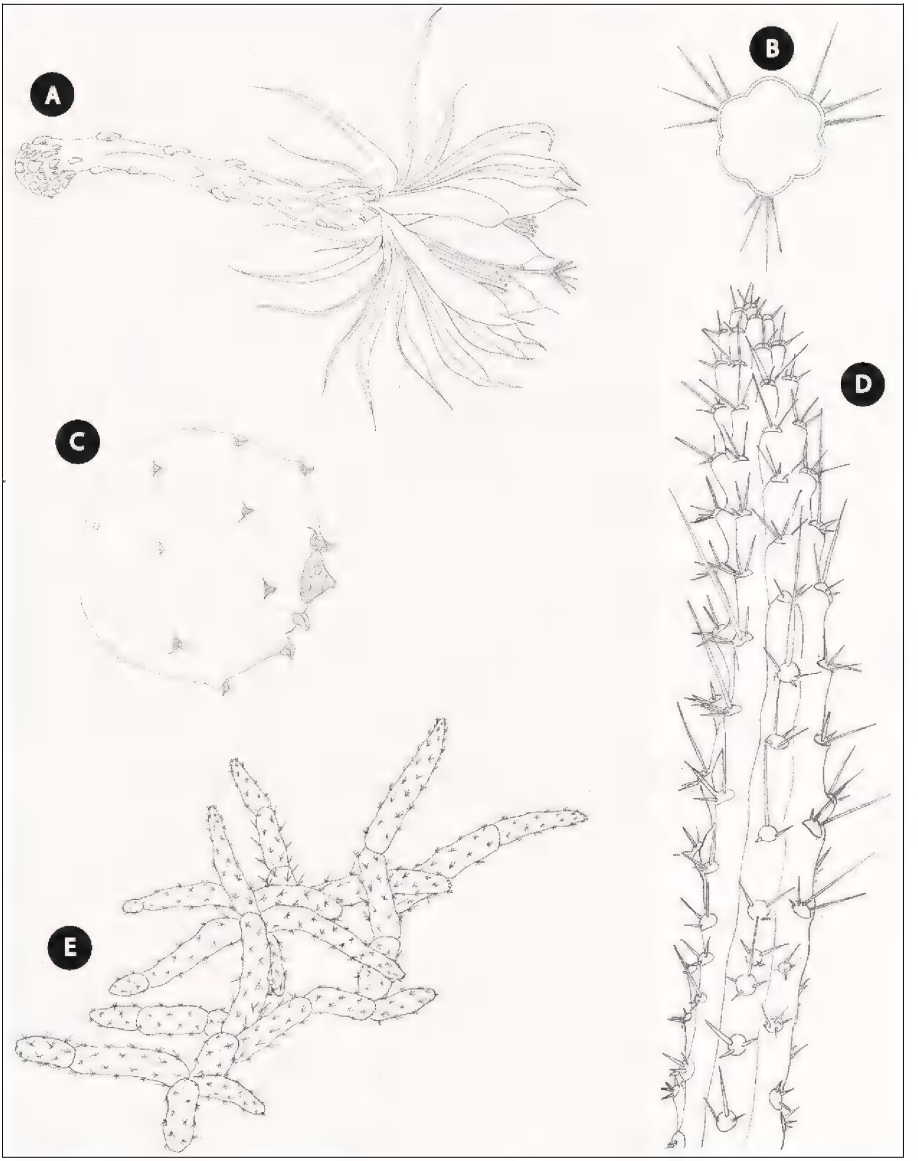

Figure 53. *Harrisia earlei*. A. Flower. B. Cross-section of stem with 6 ribs. C. Fruit. D. Stem. E. Habit. Drawings by Peter Simoes.

Figure 54. *Harrisia aboriginum.* A. Lee Co., Florida, USA. B,C,D. Sarasota Co., Florida, USA.

Figure 55. *Harrisia aboriginum.* A,D. Lee Co., Florida, USA. B,C,E. Sarasota Co., Florida, USA.

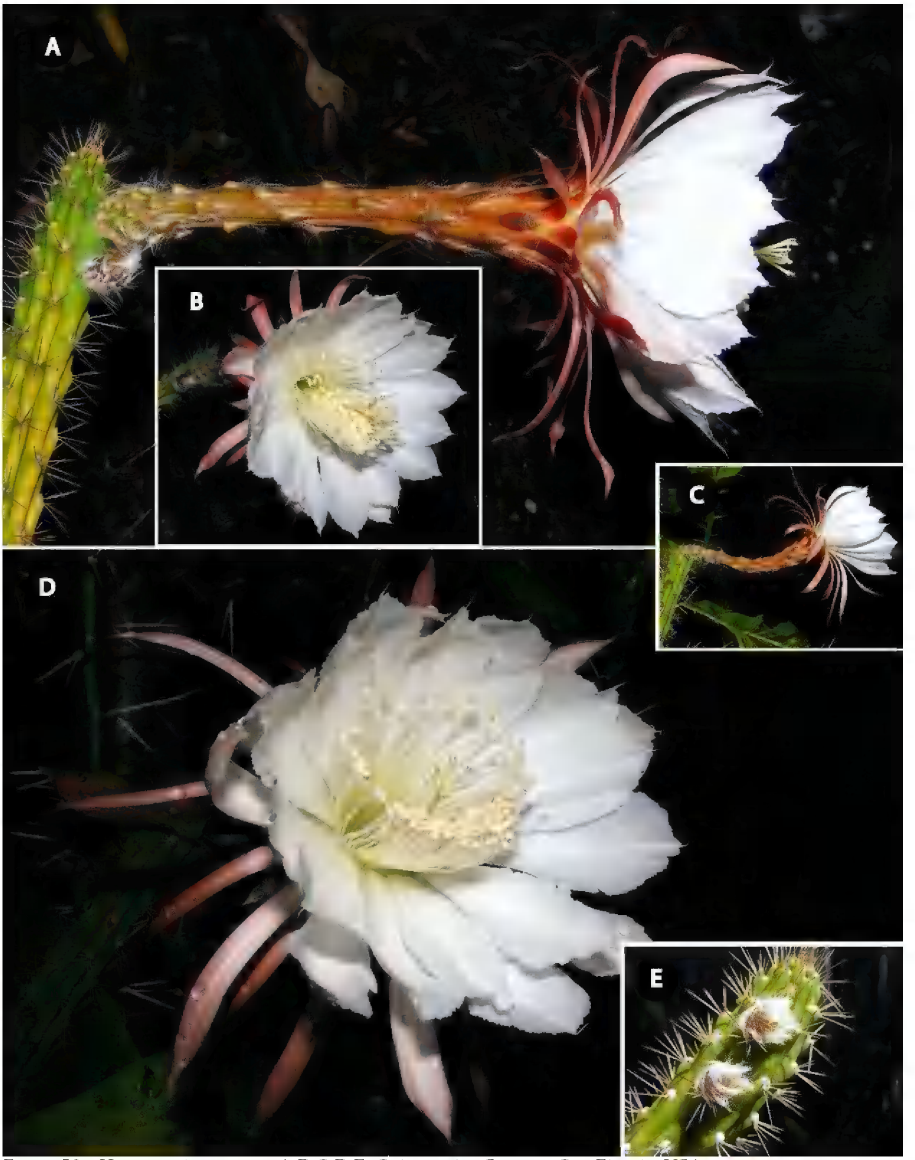

Figure 56. *Harrisia aboriginum.* A,B,C,D,E. Cultivated in Sarasota Co., Florida, USA.

Figure 57. *Harrisia aboriginum.* A. Lee Co., Florida, USA. B,C,D,E,F,G,H,I,J. Sarasota Co., Florida, USA.

Figure 58. *Harrisia aborignum*, Sarasota Co., Florida, USA, possibly being predated by *Eurycotis floridana*. A. Stem. B. Flower, probably about one day after efflorescing.

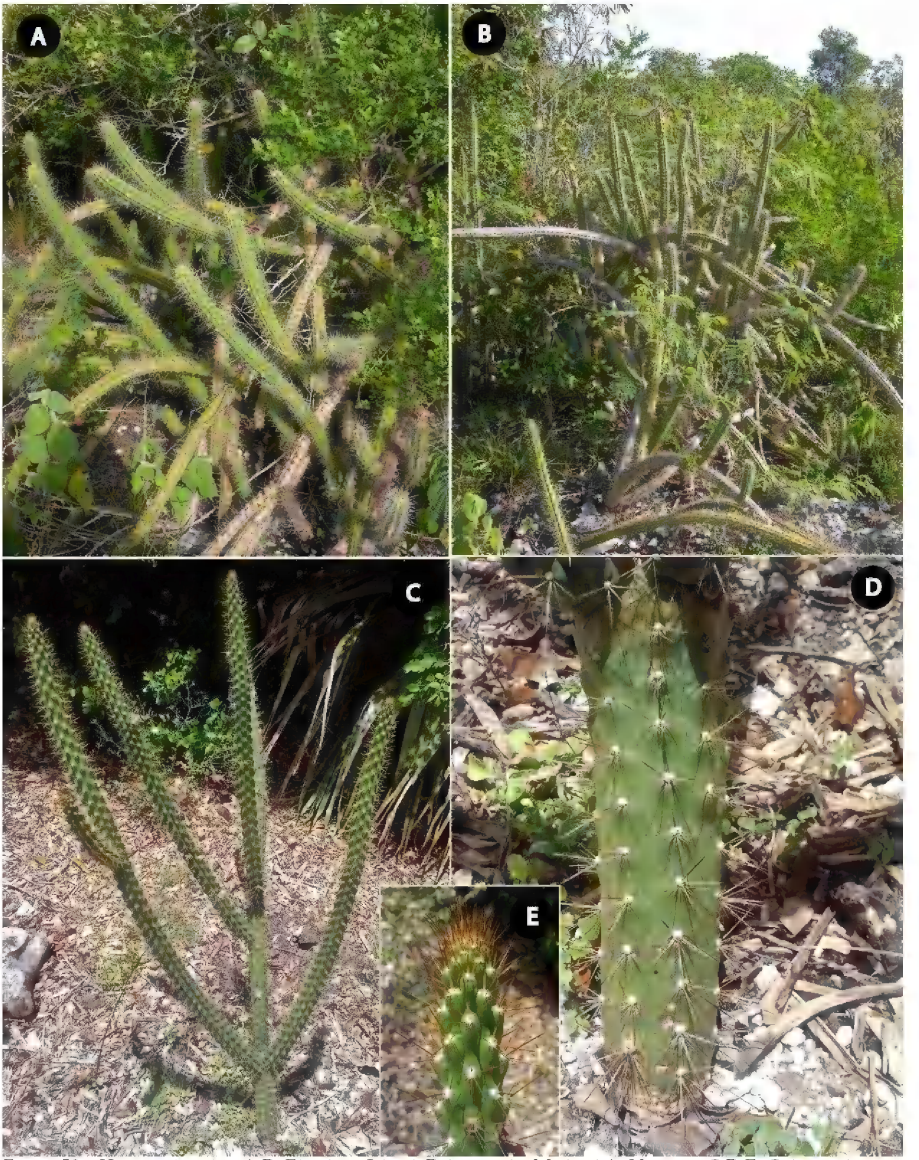

Figure 59. *Harrisia brookii*. A,B. Eleuthera Island, Bahamas, by Michael A. Vincent. C,D,E. Cultivated at Fairchild Tropical Botanic Garden, Miami-Dade Co., Florida, USA.

Figure 60. *Harrisia brookii*, cultivated in Sarasota Co., Florida, USA, originally from Long Island, Bahamas (*Franck 3033*).

Figure 61. *Harrisia brookii*, cultivated at Fairchild Tropical Botanic Garden, Miami-Dade Co., Florida, USA, originally from Long Island, Bahamas, by Kenneth Setzer.

Figure 62. *Harrisia brookii*. A,C,D. Eleuthera Island, Bahamas, by Michael A. Vincent. B. cultivated in Sarasota County, Florida, USA, originally from Long Island, Bahamas.

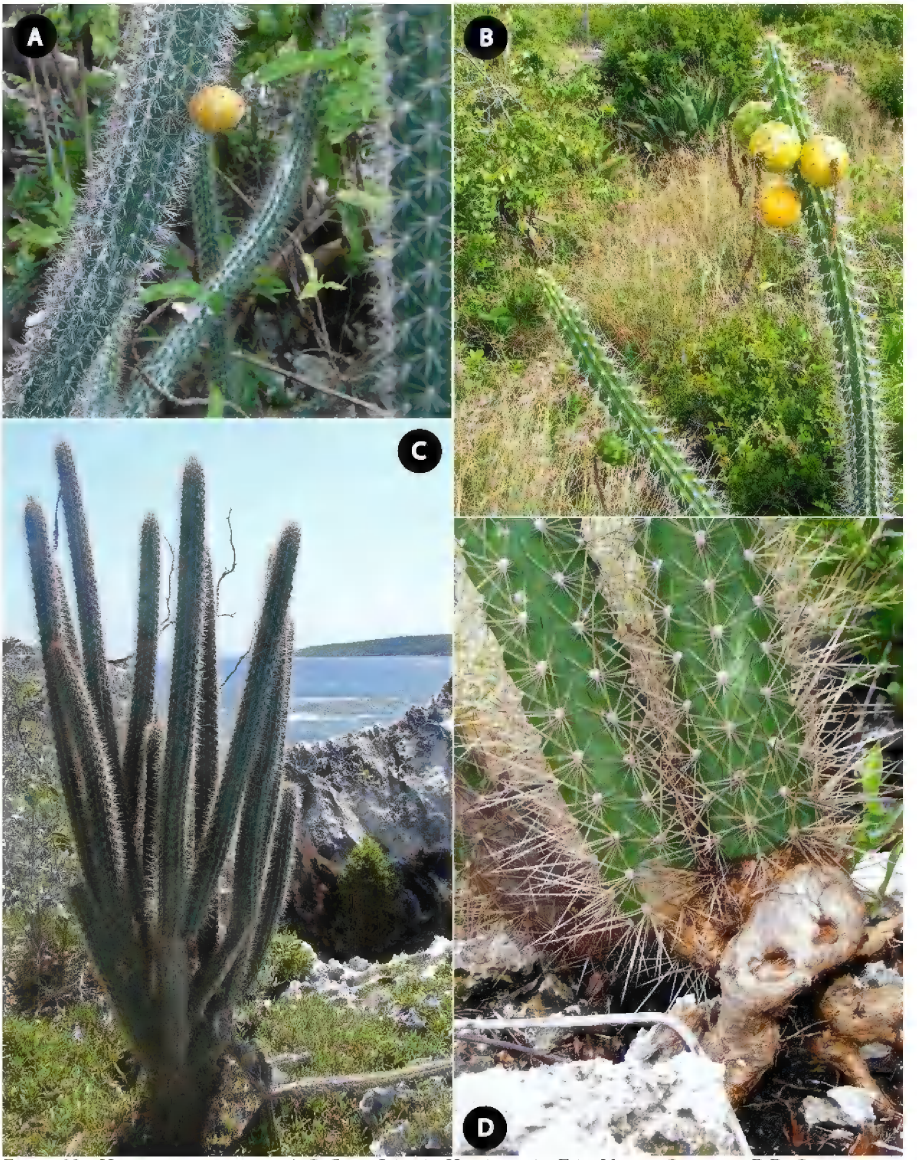

Figure 63. *Harrisia caymanensis*. A,C. Swan Islands, Honduras, by Edyi Yanina Guerrero. B,D. Cayman Islands.

Figure 64. *Harrisia caymanensis*. A. Cultivated in Sarasota Co., Florida, USA, originally from Cayman Islands (*Franck 2630*). B. Holotype, cultivated in Sarasota Co., Florida, USA, originally from Cayman Islands (*Franck 3035*).

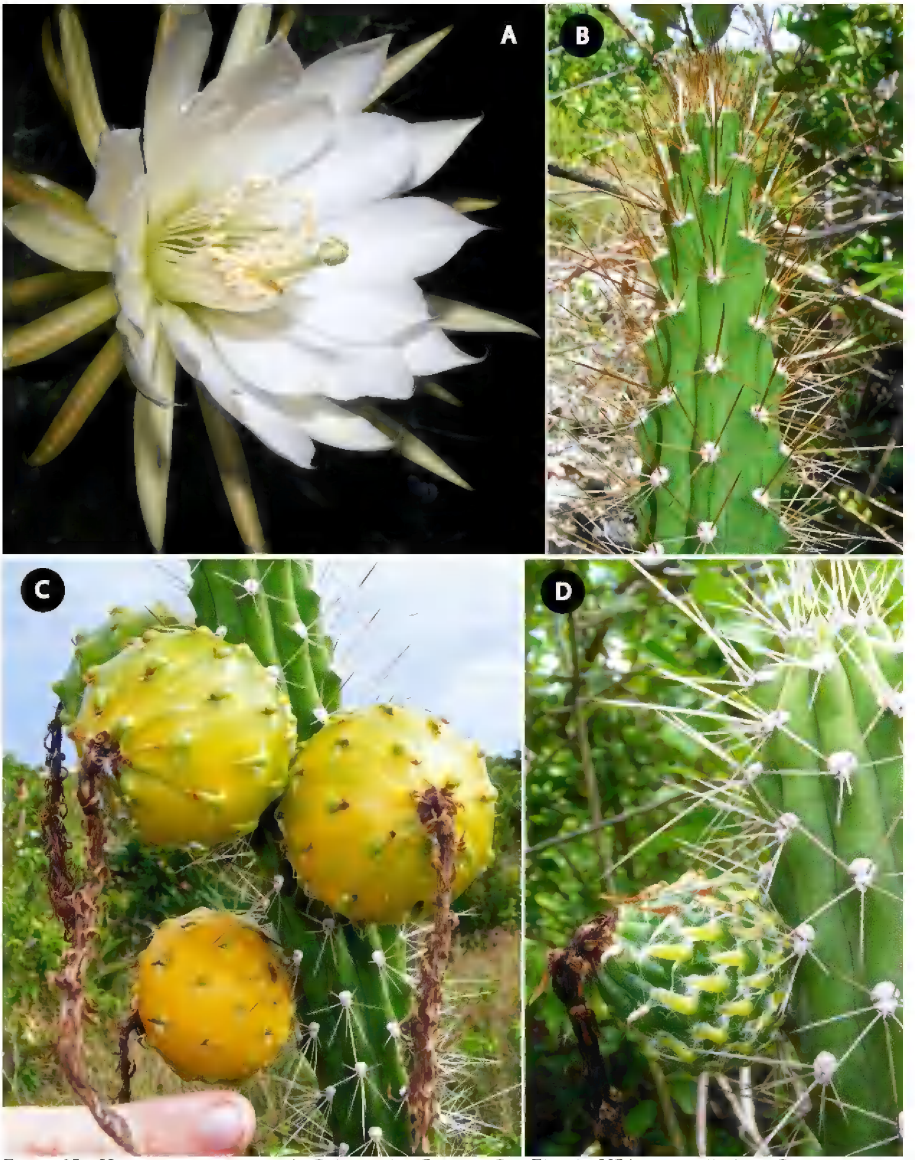

Figure 65. *Harrisia caymanensis*. A. Cultivated in Sarasota Co., Florida, USA, originally from Cayman Islands (*Franck 2630*). B,C,D. Cayman Islands.

Figure 66. *Harrisia divaricata*. A. Monte Cristi Province, Dominican Republic, by Scott Zona. B. Azua Province, Dominican Republic, by Scott Zona. C. Monte Cristi Province, Dominican Republic. D. Azua Province, Dominican Republic.

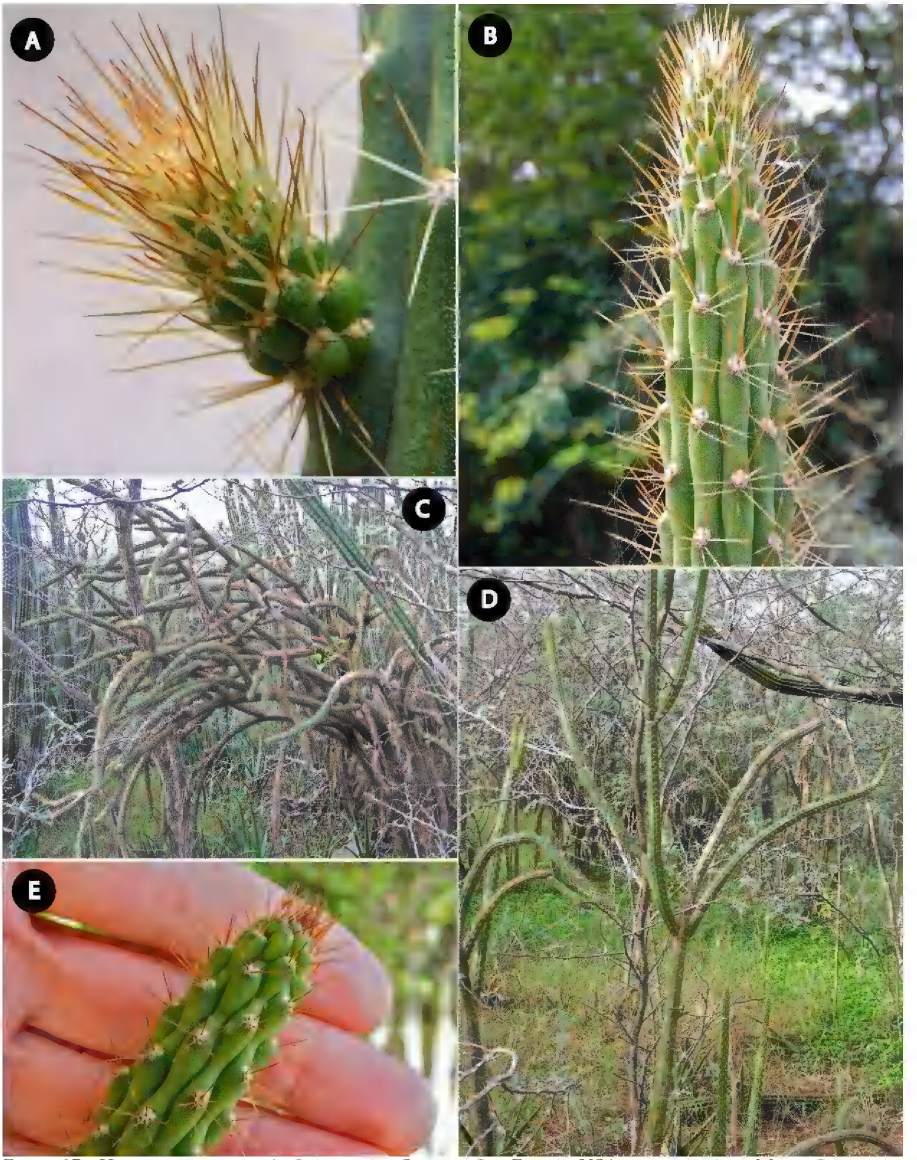

Figure 67. *Harrisia divaricata*. A. Cultivated in Sarasota Co., Florida, USA, originally from Monte Cristi Province, Dominican Republic. B,C,D. Monte Cristi Province, Dominican Republic. E. Azua Province, Dominican Republic.

Figure 68. *Harrisia divaricata*. A,B,E. Cultivated in Sarasota Co., Florida, USA, originally from Monte Cristi Province, Dominican Republic (*Franck 3021*). C. Monte Cristi Province, Dominican Republic. D. Azua Province, Dominican Republic.

Figure 69. *Harrisia divaricata*. A,B,E. Azua Province, Dominican Republic. C,D. Monte Cristi Province, Dominican Republic. F. Monte Cristi Province, Dominican Republic, by Scott Zona.

Figure 70. *Harrisia divaricata*. Île de la Tortue (Tortuga Island), Nord-Ouest Department, Haiti, by Brett Jestrow.

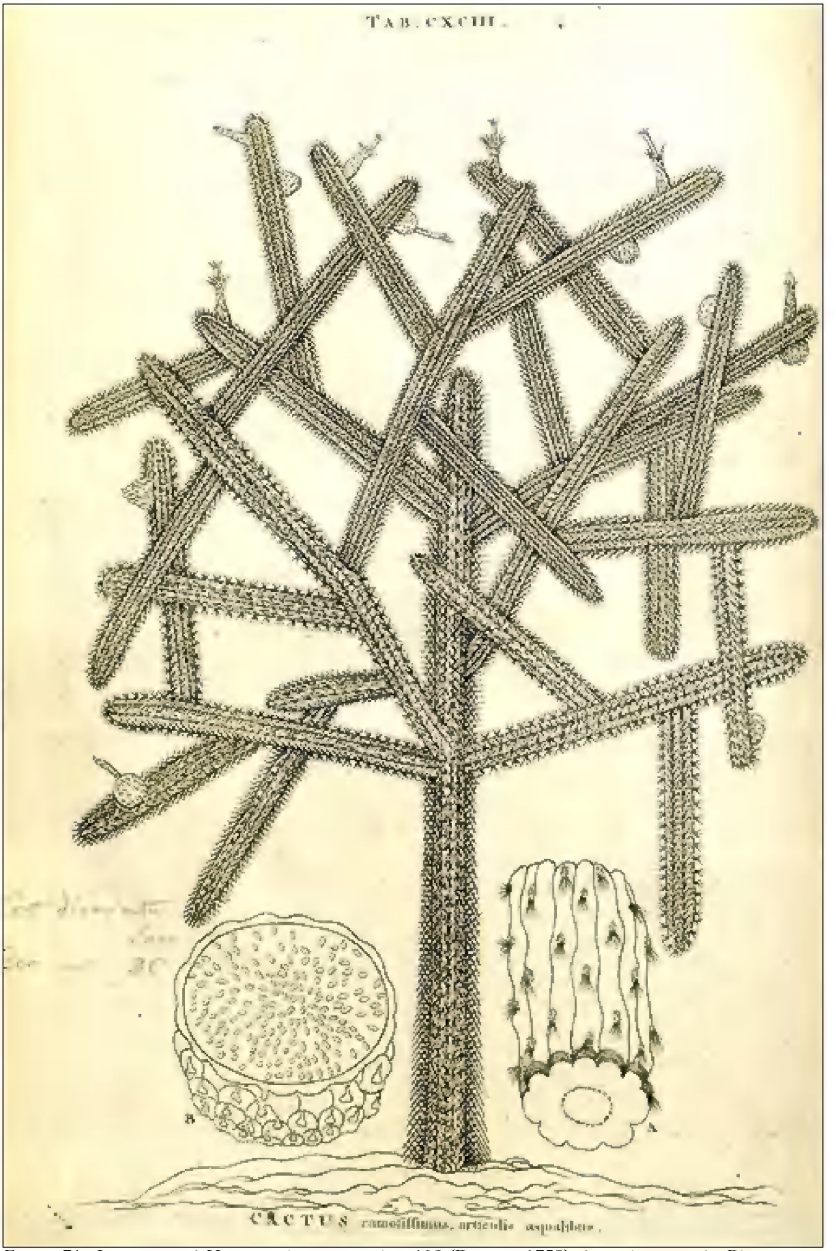

Figure 71. Lectotype of *Harrisia divaricata*, plate 193 (Burman 1758), from drawings by Plumier.

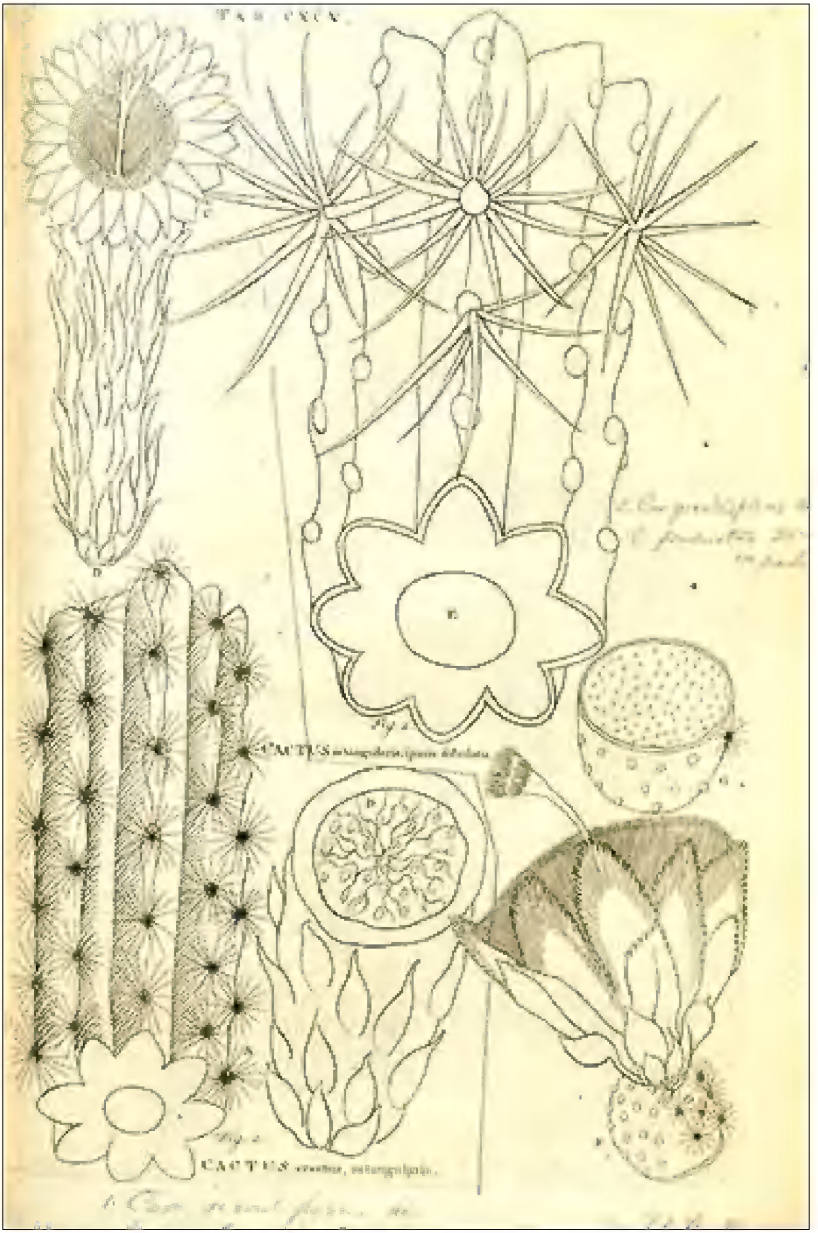

Figure 72. *Harrisia divaricata*, plate 195, fig. 1 only (Burman 1758), from drawings by Plumier. This is also the lectotype of *Cereus serruliflorus*.

Figure 73. *Harrisia divaricata*. Plate 66 (Descourtilz 1821, as "Cierge Divergent"), Haiti, illustrated by Jean-Théodore Descourtilz.

Figure 74. *Harrisia eriophora.* Zapata Peninsula, Matanzas Province, Cuba, by Armando Urquiola.

Figure 75. *Harrisia eriophora.* Zapata Peninsula, Matanzas Province, Cuba, by Raul Verdecia.

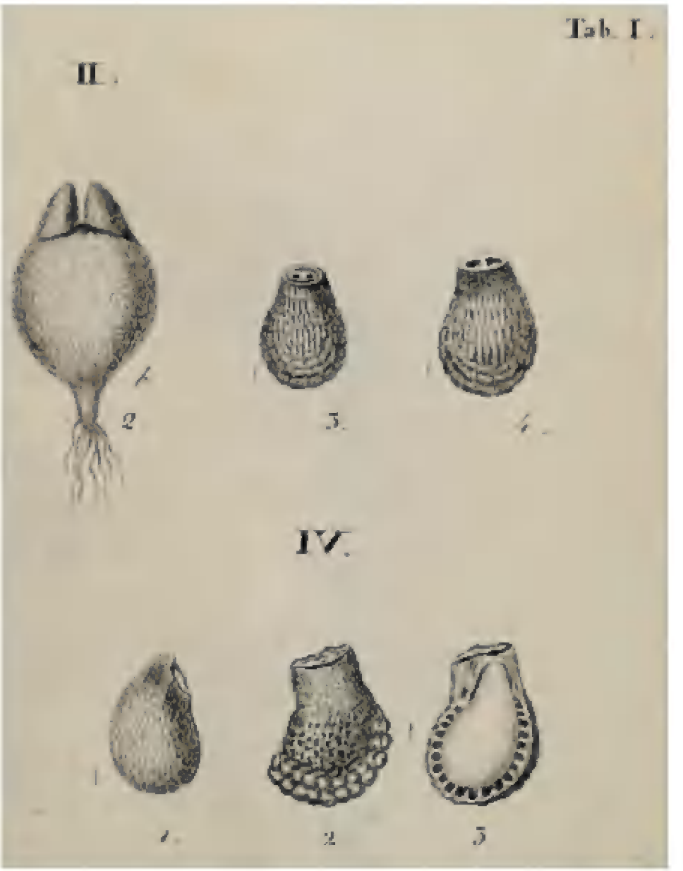

Figure 76. *Harrisia eriophora*? seed, tab. I, 'genus' IV., fig. 2 only (Zuccarini 1838, as *Cereus subrepandus*).

Figure 77. *Harrisia eriophora* seedling stages, tab. II, figs. 4–7 (Zuccarini 1838).

Figure 78. Neotype (proposed for conservation) of *Harrisia eriophora*, plate 22 (Pfeiffer & Otto 1843, as *Cereus eriophorus*).

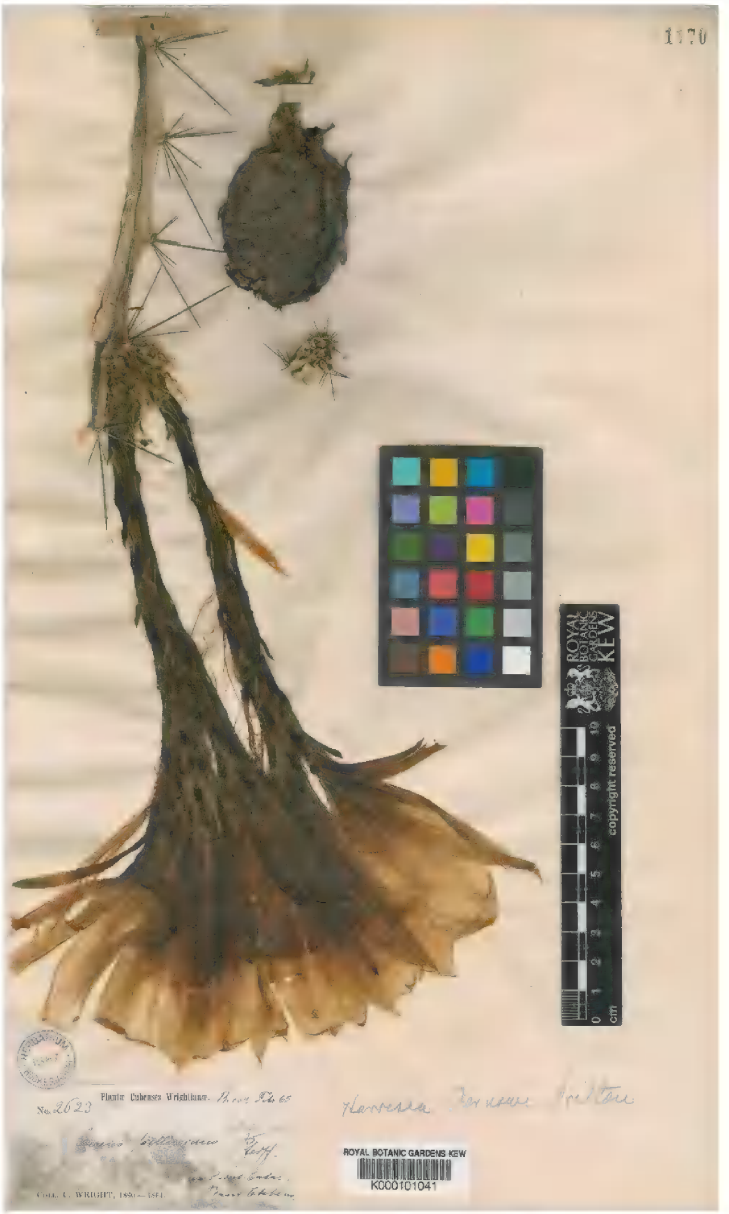

Figure 79. Probably *Harrisia eriophora*, "2623" (K), collected by Charles Wright in Cuba. © The Board of Trustees of the Royal Botanic Gardens, Kew. Reproduced with the consent of the Royal Botanic Gardens, Kew.

Figure 80. *Harrisia eriophora*. Plate18, figs 1–2 (Britton & Rose 1920), illustrated by Mary E. Eaton. Plate 18, fig. 1 is of a plant originally from Mariel, Artemisa Province, Cuba. Plate 18, fig. 2 is of a plant sent by C.F. Baker in 1907.

Figure 81. *Harrisia fernowii.* A,B. Santiago de Cuba Province, Cuba, by Zoltán Rigerszki.

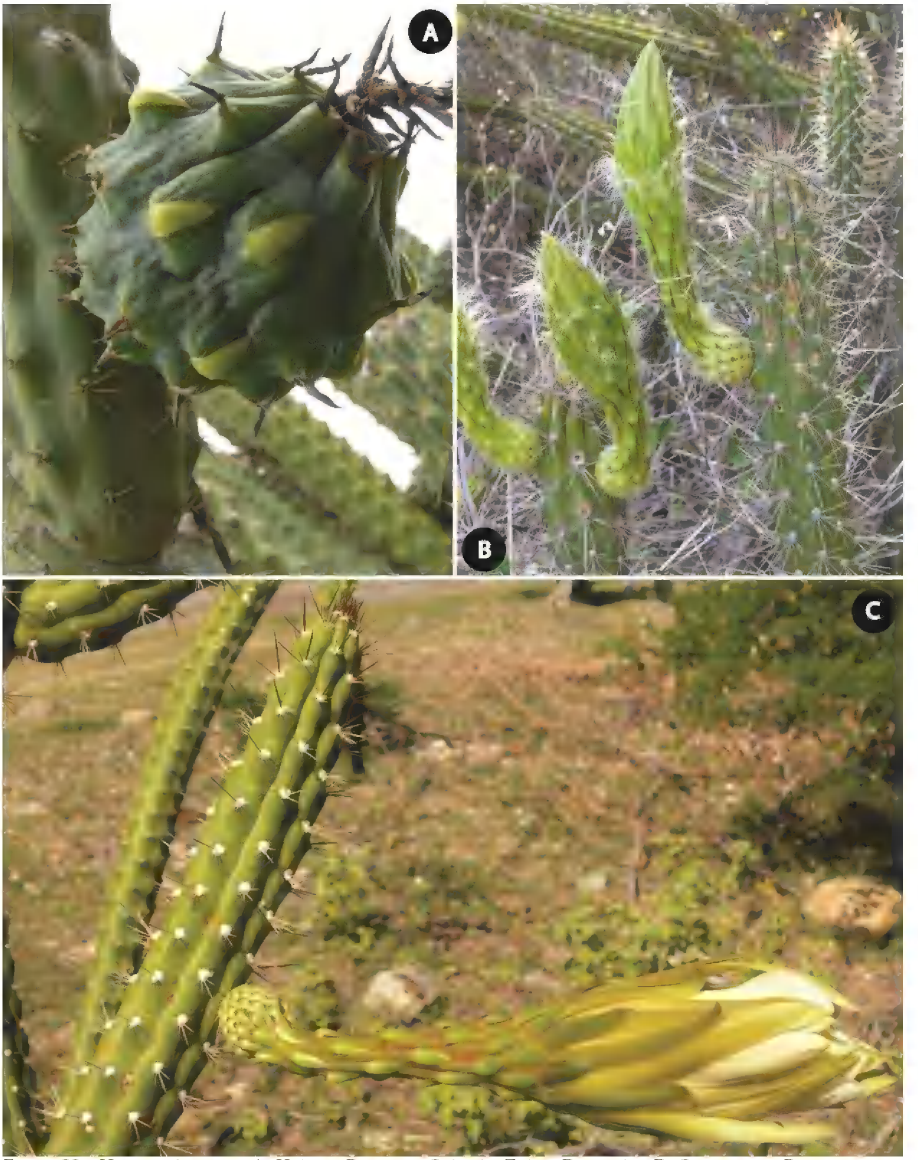

Figure 82. *Harrisia fernowii*. A. Holguín Province, Cuba, by Zoltán Rigerszki. B. Guantánamo Province, Cuba, by Zoltán Rigerszki. C. Granma Province, Cuba, by Zoltán Rigerszki.

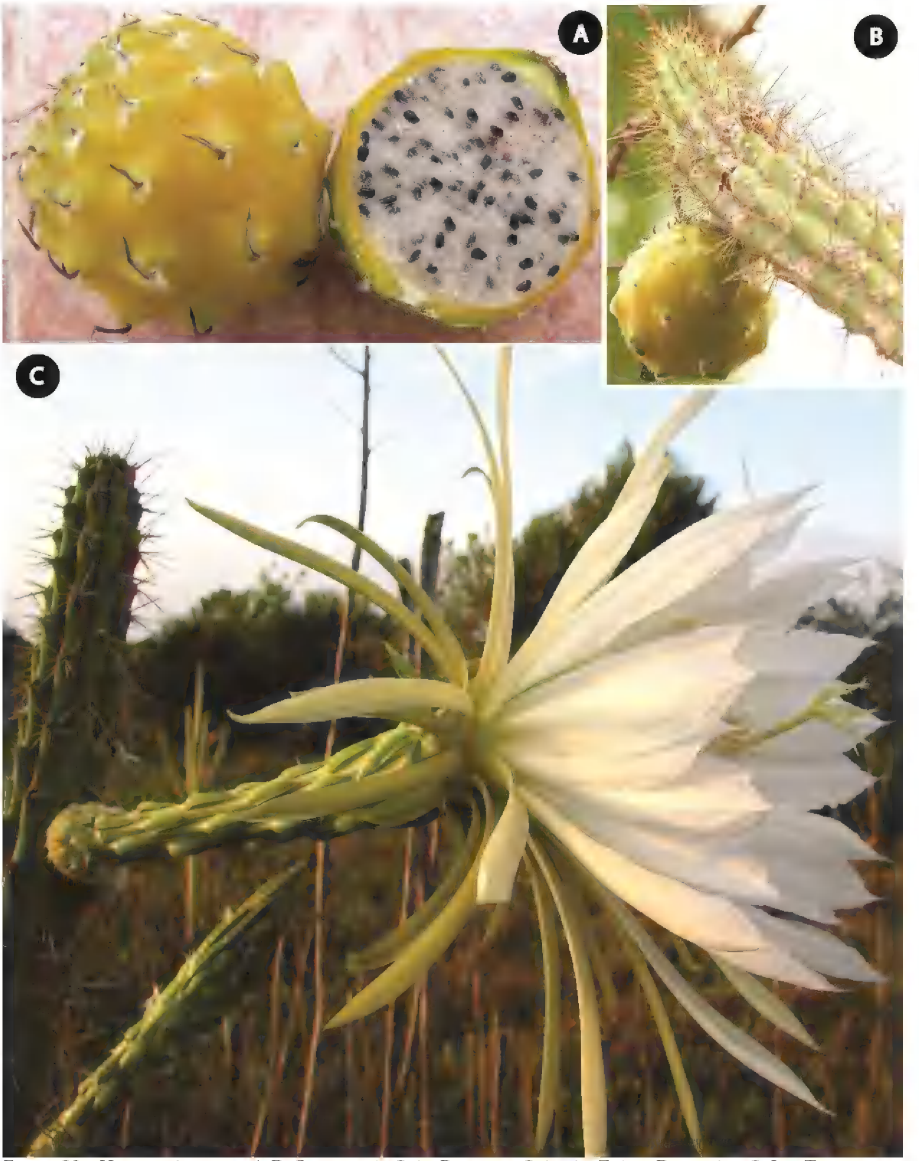

Figure 83. *Harrisia fernowii*. A,B. Santiago de Cuba Province, Cuba, by Zoltán Rigerszki. C. Las Tunas Province, Cuba, by Arianne Serrano.

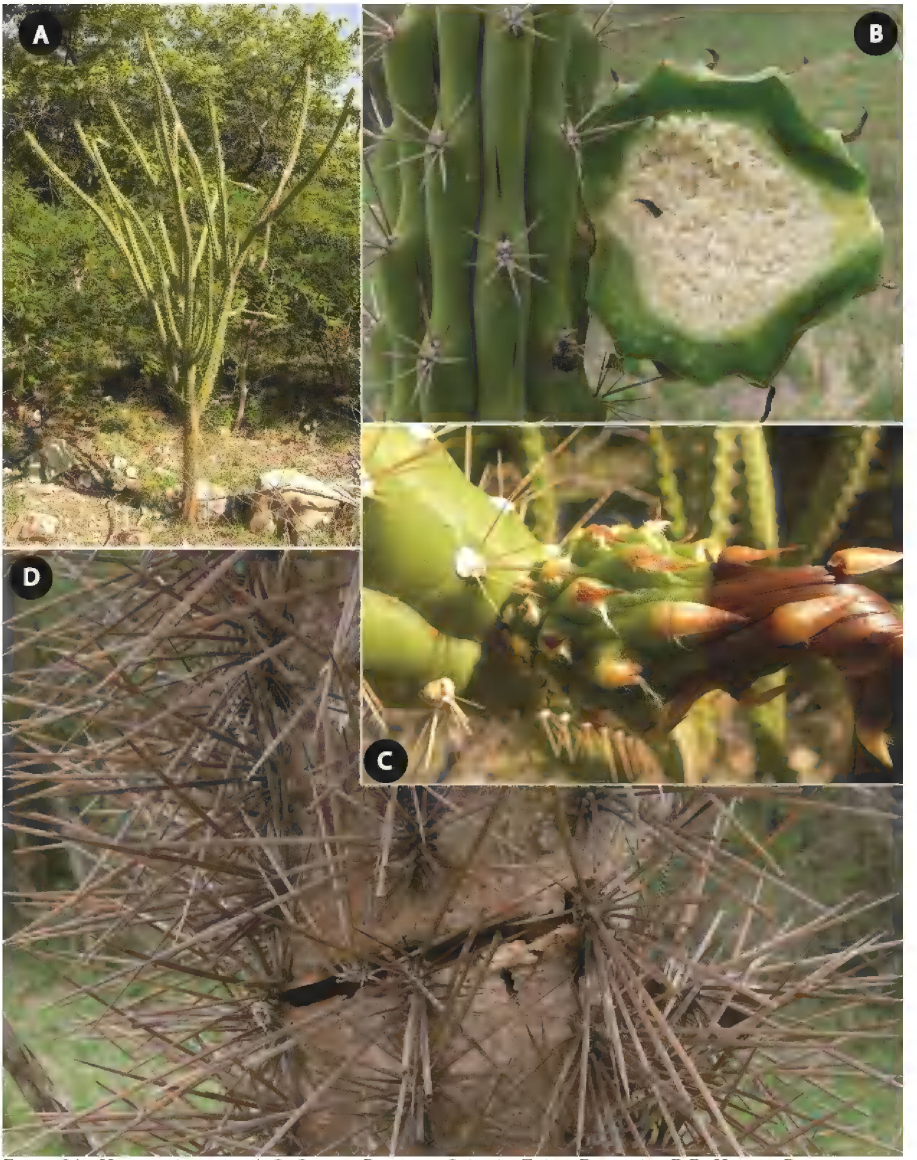

Figure 84. *Harrisia fernowii*. A,C. Granma Province, Cuba, by Zoltán Rigerszki. B,D. Holguín Province, Cuba, by Zoltán Rigerszki.

Figure 85. *Harrisia fernowii*, plate 24, fig. 1 only (Britton & Rose 1920), from the "type plant," illustrated by Mary E. Eaton. Also with *H. bonplandii*, fig. 2 only (Britton & Rose 1920).

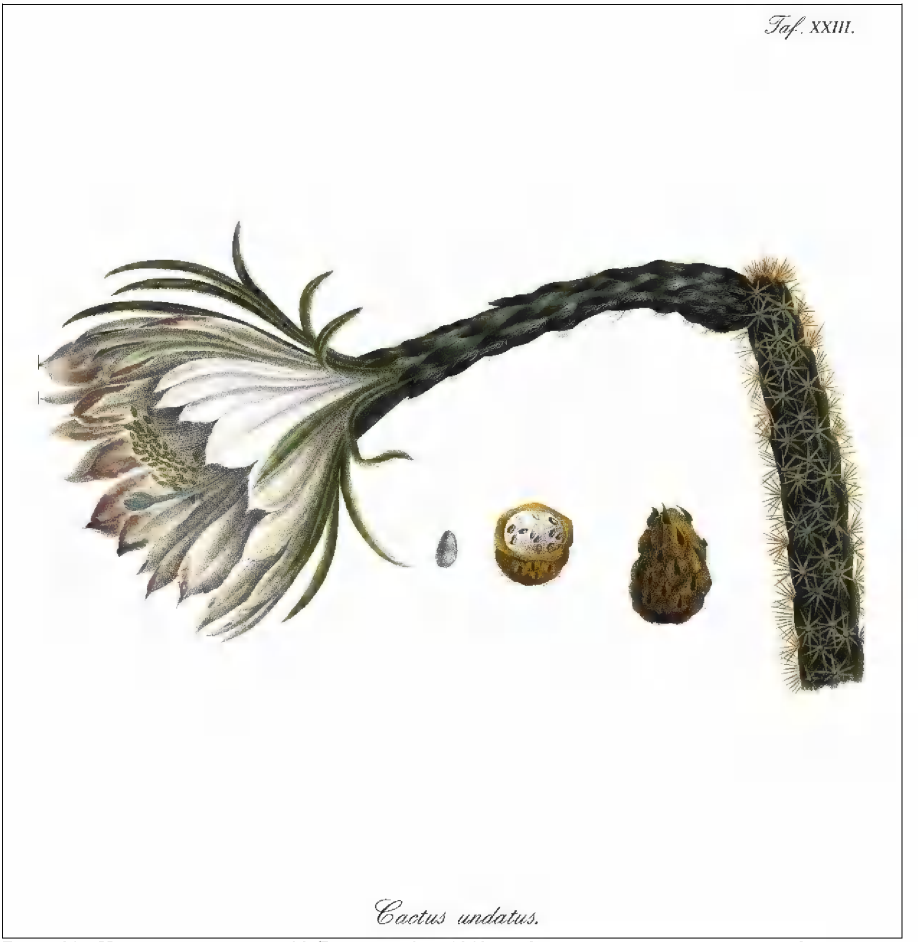

Figure 86. *Harrisia fernowii*, plate 23 (Pfeiffer & Otto 1843, as *Cactus undatus* and in the text as *Cereus undatus*). Britton & Rose (1920: 152, fig. 222) attributed this illustration to *H. gracilis*, but the shape and arrangment of the scales exhibit a better affinity with *H. fernowii*.

MONOGRAPH OF *HARRISIA* (CACTACEAE), PART 5, FIGS. 87–111

ALAN R. FRANCK, University of South Florida

Figure 87. *Harrisia fragrans*. A,B. Monroe Co., Florida, USA. C. Miami-Dade Co., Florida, USA.

Figure 88. *Harrisia fragrans*. A,B. Cultivated in Sarasota Co., Florida, USA, originally from Miami-Dade Co. (same cuttings as *Franck 1236*). C– Monroe Co., Florida, USA.

Figure 89. *Harrisia fragrans*. A. Cultivated in Sarasota Co., Florida, USA, originally from Miami-Dade Co. (same cuttings as *Franck 1236*). B. Cultivated in Sarasota Co., Florida, USA, originally from Monroe Co. (same cutting as *Franck 2203*).

Figure 90. *Harrisia fragrans*. A. Cultivated in Sarasota Co., Florida, USA, originally from Indian River Co. (left, *Franck 2974*) and St. Lucie Co. (right, *Franck 3160*). B. Monroe Co., Florida, USA. C. Cultivated in Sarasota Co., Florida, USA, originally from Indian River Co. (right, *Franck 2974*) and St. Lucie Co. (left, *Franck 3160*).

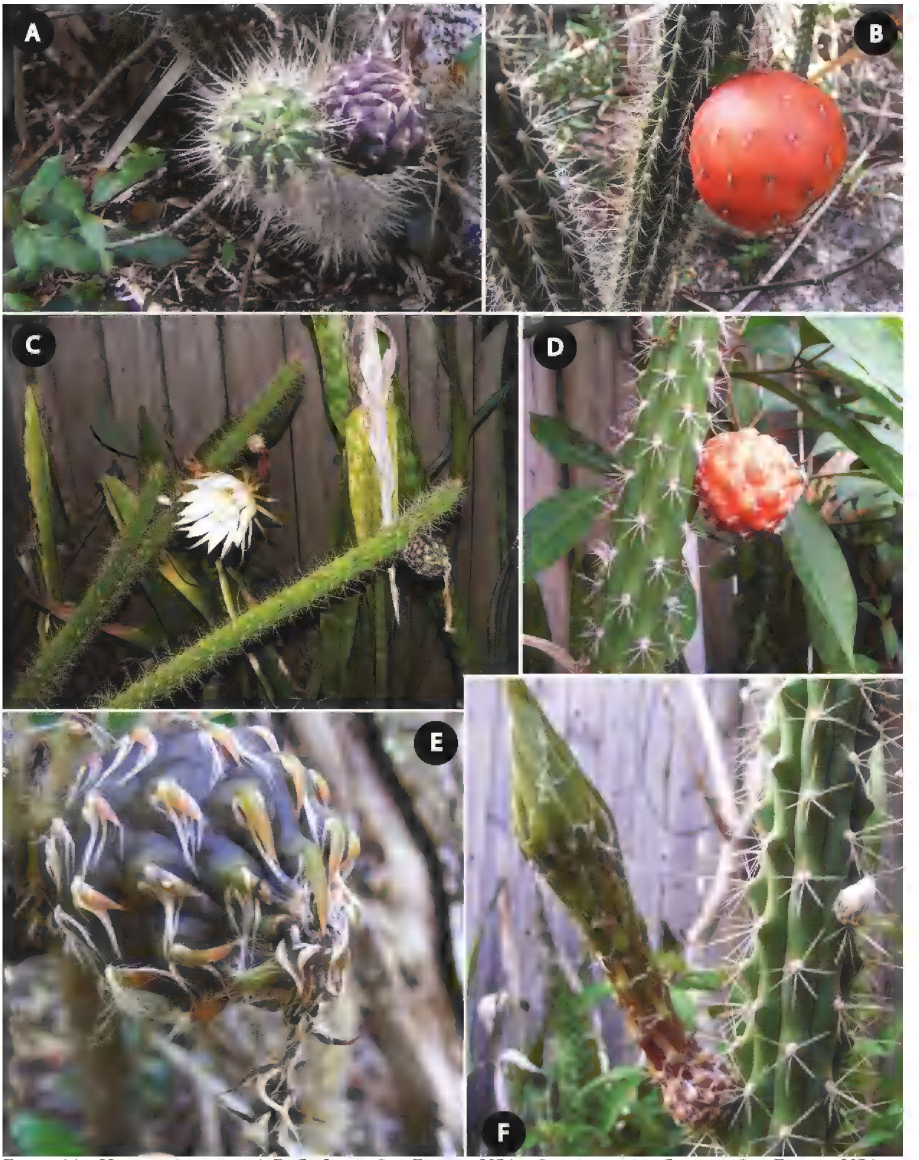

Figure 91. *Harrisia fragrans*. A,B. St. Lucie Co., Florida, USA. C. cultivated in Sarasota Co., Florida, USA, originally from St. Lucie Co. (left, *Franck 3160*, and right made into *Franck 3175* a month later). D. Cultivated in Sarasota Co., Florida, USA, originally from Miami-Dade Co. E. Monroe Co., Florida, USA. F. Cultivated in Sarasota Co., Florida, USA, originally from Monroe Co. (two days later effloresing and made into *Franck 2627*).

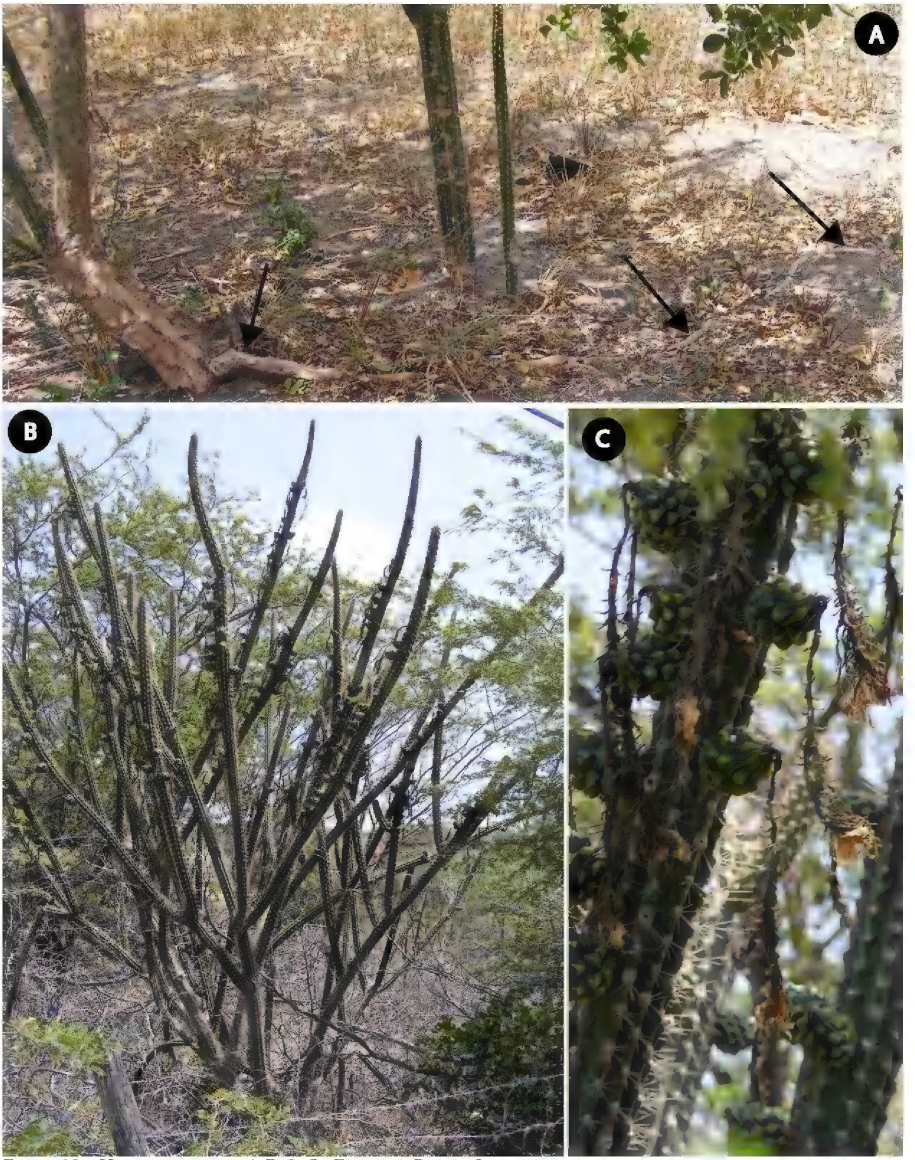

Figure 92. *Harrisia gracilis*. A,B,C. St. Elizabeth Parish, Jamaica.

Figure 93. *Harrisia gracilis*. A,B. St. Elizabeth Parish, Jamaica.

Figure 94. *Harrisia gracilis*. Fasciated stem, St. Andrew Parish, Jamaica.

Figure 95. *Harrisia gracilis*. Fasciated stem, St. Andrew Parish, Jamaica.

Figure 96. *Harrisia gracilis*. Young stem with succulent flesh rotted away leaving only the woody fibers, St. Elizabeth Parish, Jamaica.

Figure 97. *Harrisia gracilis.* Cross-section showing woody stem of trunk, St. Elizabeth Parish, Jamaica.

Figure 98. *Harrisia gracilis*. A. Cultivated in Sarasota Co., Florida, USA. B,D. St. Andrew Parish, Jamaica. C,E. Cultivated at the University of West Indies, St. Andrew Parish, Jamaica.

Figure 99. *Harrisia gracilis*. A,B. Cultivated in Sarasota Co., Florida, USA, originally from Clarendon Parish, Jamaica (*Franck 2661*).

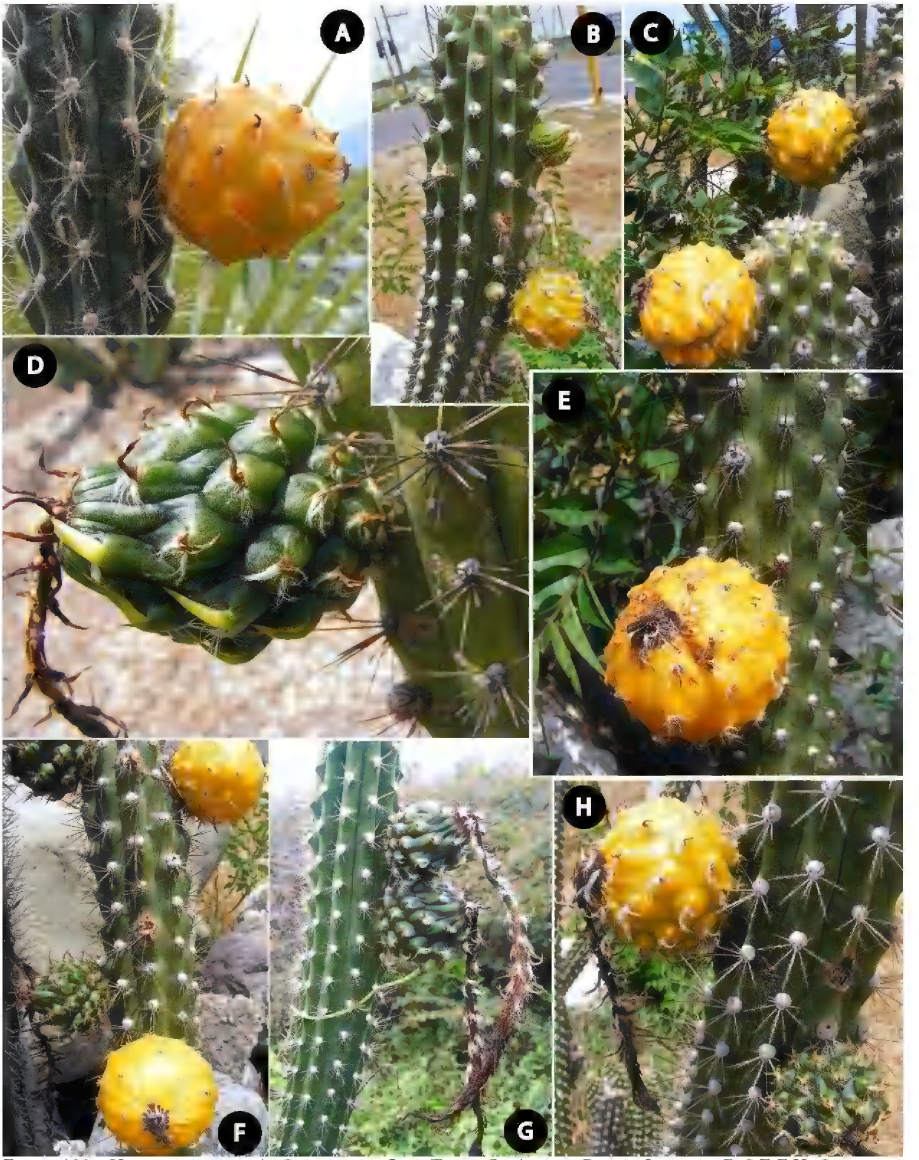

Figure 100. *Harrisia gracilis*. A. Cultivated in Irish Town, St. Andrew Parish, Jamaica. B,C,E,F,H. Cultivated at roundabout, St. Catherine Parish, Jamaica. D. Cultivated at the University of West Indies, St. Andrew Parish, Jamaica. G. St. Andrew Parish, Jamaica.

Figure 101. Probably *Harrisia gracilis*, and likely the earliest known specimen of *Harrisia*, from the herbarium of Abbé Daenen (as *Cactus repandus*), received 1864, at G (© : Conservatoire et Jardin botaniques de la Ville de Genève).

Tab. XIV
a. Semen maturum, b. in magnitudine auctum.
CEREUS altissimus gracilior, fructu ex-
tus luteo intus niveo, seminibus nigris ple-
no Sloā. Cat. Jam. p. 197. Pluknet. T. II. p. 158. Raii Hist.
T. III. dendrol. p. 22. Mill. Gard. dict.

Figure 102. Lectotype of *Harrisia gracilis* (Trew 1751).

Figure 103. *Harrisia gracilis*. Plate 336 (Edwards & Lindley 1818, as *Cactus repandus*), from the nursery of Messrs. Whitley, Brames, and Milne, Fulham, England.

Figure 104. *Harrisia gracilis*. Plate 61 (Britton 1917b), illustrated by Mary E. Eaton from a plant at the New York Botanical Garden which came from John F. Cowell in 1904.

Figure 105. *Harrisia portoricensis*. A,B,C,D. Mona Island, Puerto Rico, by Erik Oberg (copyright Island Conservation).

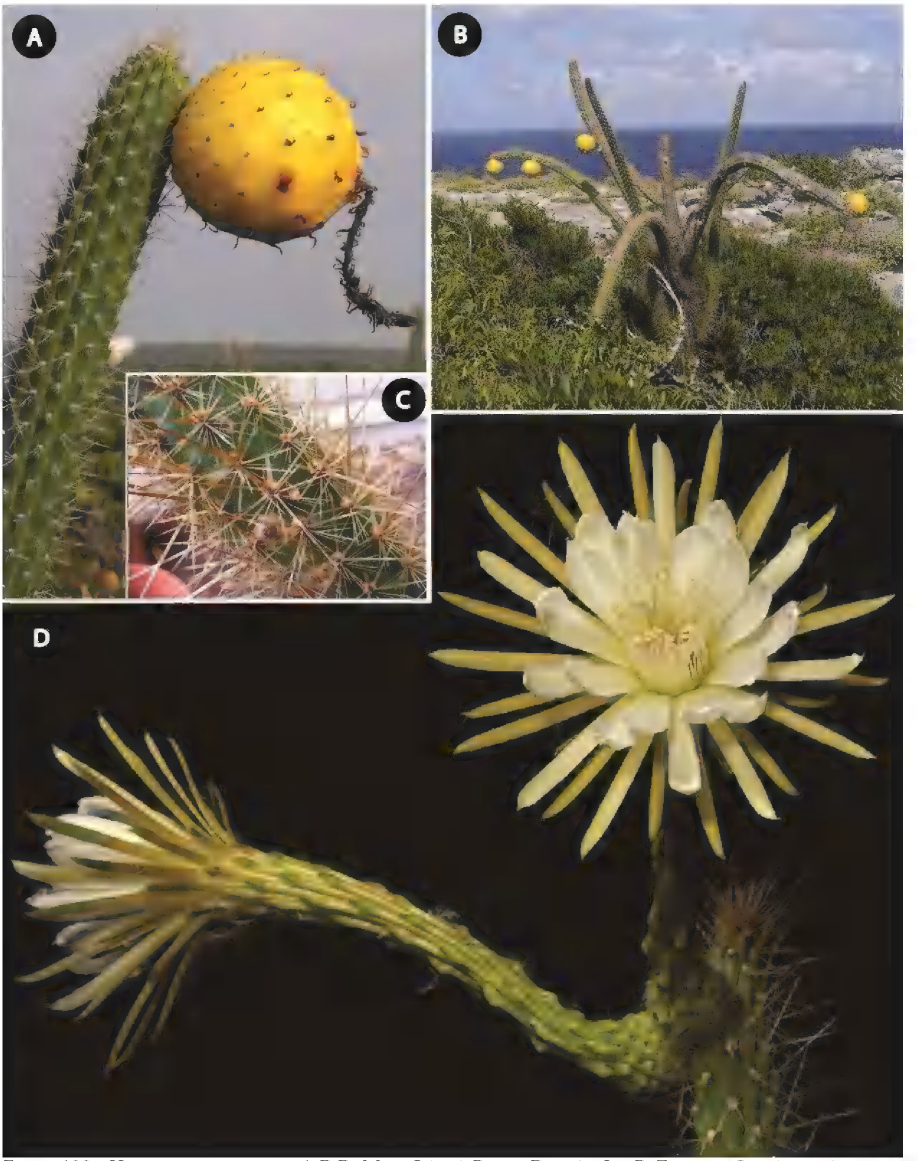

Figure 106. *Harrisia portoricensis*. A,B,D. Mona Island, Puerto Rico, by Jan P. Zegarra. C. cultivated in Sarasota Co., Florida, USA, originally from Mona Island, Puerto Rico.

BRITTON AND ROSE, VOL. II
PLATE XVII
1
2
3
M. E. Eaton del.
1. End of flowering branch of *Heliocereus elegantissimus*.
2. End of a flowering branch of *Heliocereus speciosus*.
3. A tip of a fruiting branch of *Harrisia portoricensis*.
(All natural size.)

Figure 107. *Harrisia portoricensis*. Plate 18, fig. 3 only (Britton & Rose 1920), from near Ponce, Puerto Rico, illustrated by Mary E. Eaton.

Figure 108. *Harrisia taetra*. Pinar del Río Province, Cuba, by Armando Urquiola.

Figure 109. *Harrisia taetra*. Pinar del Río Province, Cuba, by Armando Urquiola.

Figure 110. *Harrisia taetra*. Pinar del Río Province, Cuba by D.A. Kolterman.

Figure 111. The author, 25 Sep 2010, Monte Cristi Province, Dominican Republic, by Scott Zona.

Semple, J.C., T. Shea, M. El-Swesi, H. Rahman, and Y. Ma. 2016. A multivariate study of the *Solidago stricta* complex (Asteraceae: Astereae: *Solidago* subsect. *Maritimae*). Phytoneuron 2016-86: 1–34. Published 20 December 2016. ISSN 2153 733X

A MULTIVARIATE STUDY OF THE *SOLIDAGO STRICTA* COMPLEX (ASTERACEAE: ASTEREAE: *SOLIDAGO* SUBSECT. *MARITIMAE*)

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ABSTRACT

A multivariate morphometric study of the *Solidago stricta* complex of *S.* subsect. *Maritimae* was performed to assess statistical support for recognizing *S. austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata* as separate species. Ten analyses were run and discussed.

*Solidag*o subsect. *Maritimae* (Torr. & Gray) G.L. Nesom includes all the bog and marsh goldenrod species with sheathing proximal basal rosette and lower stem leaves. The *Solidago stricta* Ait. complex includes six of the more inland or at least non-salt marsh inhabiting species native to the inner and outer coastal plains and southern piedmont regions of the eastern U.S.A. (Semple 2016 frequently updated; Semple et al. 2016): *S. austrina* J.K. Small (Fig. 1) native to wetter soils on the piedmont generally at 50 m elevation or higher; *S. chrysopsis* J.K. Small of South Florida and the keys (Fig. 2); *S. gracillima* Torrey & A. Gray (Fig. 3) native to the inner coastal plain and outer piedmont in habitats that may be rather wet in the spring but tend to be much drier in the summer and earlier fall; *S. pulchra* J.K. Small (Fig. 4) native to outer coastal plain boggy ground with *Sphagnum* in southeastern North Carolina; *S. stricta* Ait. (sensu stricto, not of authors; Figs. 5-6) native to moist argillaceous sand soils in eastern Virginia and the pine barons of southern New Jersey and disjunct in a few locations further south; and *S. virgata* Michx. (Fig. 7) native to the coastal plain at 5-40 m elevation from eastern North Carolina to Louisiana. The ranges of all six species are illustrated in Fig. 8.

Floristic treatments of the *Solidag*o *stricta* complex have varied considerably during the past century and a half. Torrey and A. Gray (1841) misapplied the name *S. stricta* to the northern bog goldenrod *S. uliginosa* Nutt. and treated the southern species as *S. virgata*. In his large report on chromosome numbers in *Solidago*, Beaudry (1963) noted that *S. stricta* was "probably an aggregate of more than one species." Cronquist (1968) recognized the north species as *S. uliginosa* (stems usually hairy in the inflorescence), lumped several species into his *S. stricta* (stems usually glabrous in the inflorescence; rhizomatous) occurring from the Atlantic coastal plain of New Jersey to Texas, and separated out *S. austrina* as lacking rhizomes and occurring from Virginia to Georgia. Cronquist (1980) further divided his *S. stricta* into three species: *S. stricta* with long slender, stoloniferous rhizomes, *S. pulchra* without the rhizomes and with few heads (5-25) with many florets, and *S. gracillima* with many heads (more than 20) and fewer florets; he also stated that some *S. uliginosa* in North Carolina was transitional with *S. gracillima* (*S. simulans* Fernald treated as a synonym). Cronquist (1980) placed *S. austrina*, *S. flavovirens* Chapman, and *S. perlonga* Fern. in synonymy under his *S. stricta*. Semple and Cook (2006) followed Cronquist (1980) in recognizing *S. pulchra* but included *S. gracillima* in *S. stricta* as a subspecies (and *S. austrina*, and *S. perlonga* as synonyms of the subspecies); and they listed *Solidago chrysopsis* Small; *S. flavovirens* Chapman; *S. stricta* var. *angustifolia* (Elliott) A. Gray as synonyms of subsp. *stricta*. Based on multiple field trips after Flora North America was published, Semple (2012) selected a lectotype for *S. gracillima*, thereby restricting the species to plants of the complex with a few long to very long lower inflorescence branches, as is done here; he recognized *S. austrina* as a piedmont species with inflorescences with many branches that graded from short to distally short to proximately

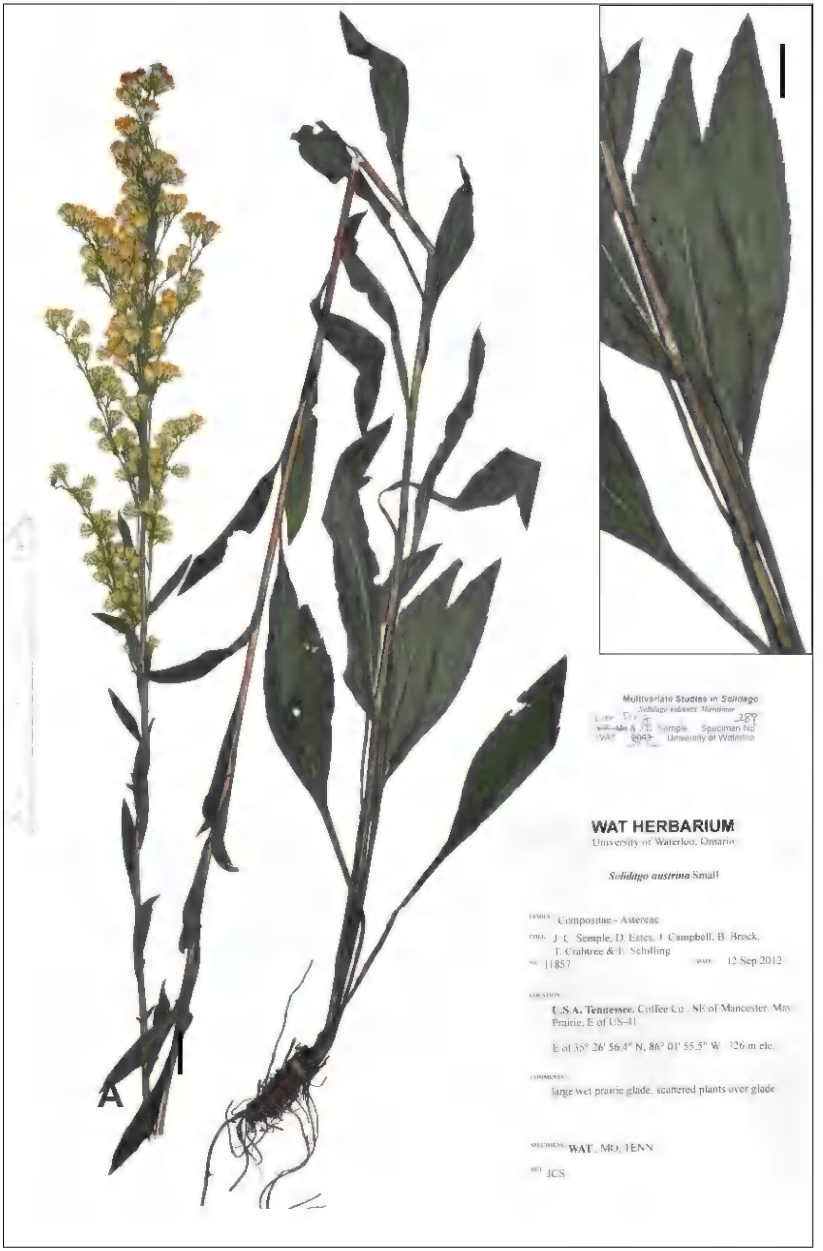
A
Multivariate Studies in Solidago
Solidago subsect. Maximae
Sample Specimen No
University of Waterloo
WAT HERBARIUM
University of Waterloo, Ontario
Solidago austrina Small
Compositae – Astereae
J. C. Semple, D. Estes, J. Campbell, B. Brock,
T. Crabtree & E. Schilling
11857
12 Sep 2012
U.S.A. Tennessee. Coffee Co., NE of Manchester, Mtn
Prairie, E of US-41
E of 35° 26' 56.4" N, 86° 01' 55.5" W 326 m elev.
large wet prairie glade, scattered plants over glade
WAT, MO, TENN
JCS

Figure 1. Example of *Solidago austrina* used in the multivariate study: *Semple et al.* 11857 (WAT, unmounted when digital photograph was taken).

Solidago stricta Ait.
Between Homestead & Miami, Dade Co., Fla.
VIII · 19 · 49 T. Daggy
Phyllaries smaller, broader, more obtuse than described. Achenes pubescent.
5943
Solidago chrysopsis Small
Det. John C. Semple 2011
WAT University of Waterloo

Figure 2. Example of *Solidago chrysopsis* used in the multivariate study: *Daggy 5943* (UNCC); note the very linear basal stem leaves.

B. K. Godfrey Herbarium (FSU)
HERBARIUM
142829
FLORIDA STATE UNIVERSITY
Multivariate Studies in Solidago
Rahman, J. C. Semple Specimen No 261
WAT 2003 University of Waterloo
OF FLORIDA STATE UNIVERSITY, TALLAHASSEE
PLANTS OF: FLORIDA COUNTY: LEON
Solidago austrina Small
Pine-oak-hickory woods on Welaunee Plantation near Miccosukee Road between I-10 and Crump Road.
DATE: October 7, 1974
COLLECTED BY: A. F. Clewell
NO. DET.
SOLIDAGO GRACILLIMA T. & G.
Det. by B. K. Godfrey, 1980
FLORIDA STATE UNIVERSITY HERBARIUM

Figure 3. Example of *Solidago gracillima* used in the multivariate study: *Clewell s.n.* (FSU).

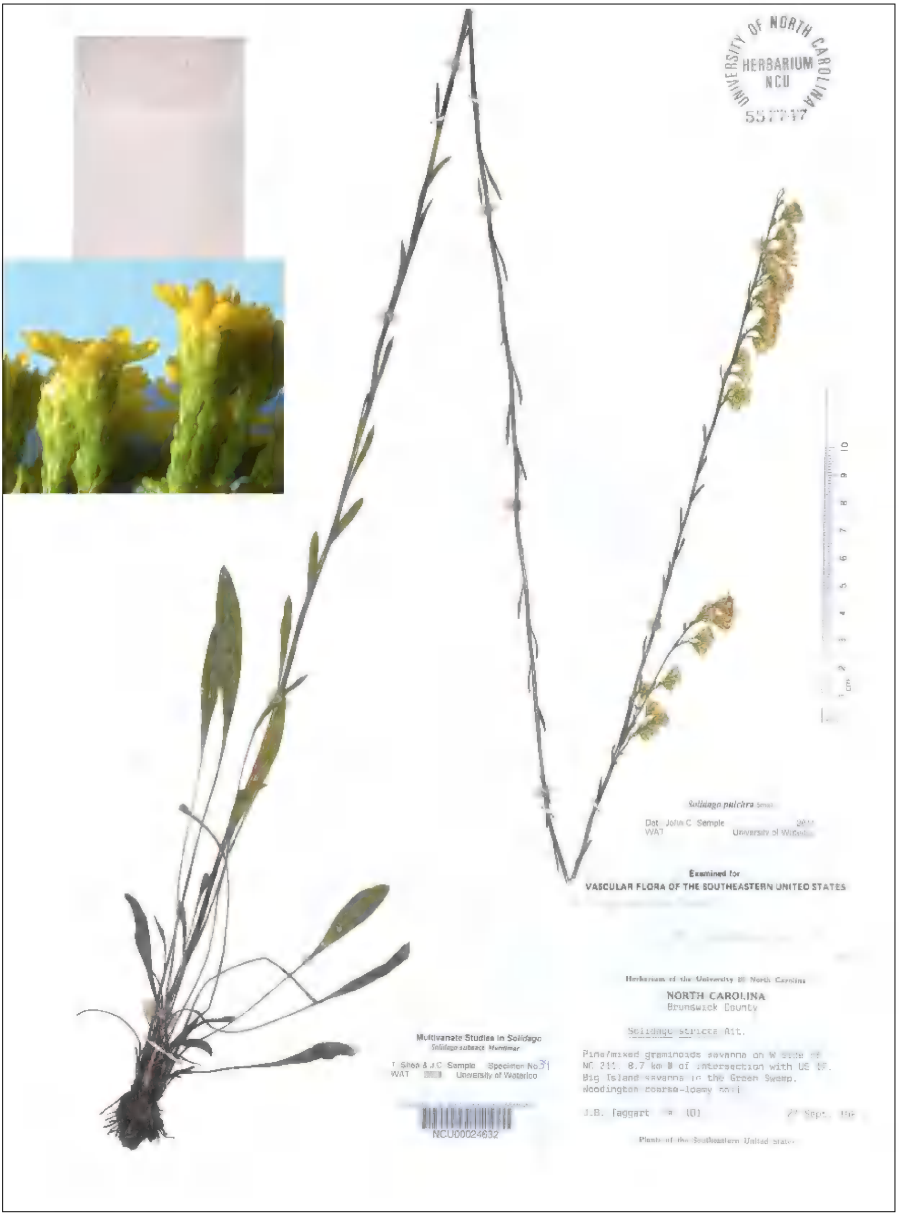

Figure 4. Example of *Solidago pulchra* used in the multivariate study: *Taggart 101* (NCU), tip of inflorescence damaged resulting in lateral branch elongation lower on stem; color insert of heads in field, voucher is *Semple & Suripto 9755* (WAT).

WAT
HERBARIUM
DEPARTMENT OF BIOLOGY
UNIVERSITY OF WATERLOO
WATERLOO ONTARIO
CANADA N2L 3G1
WAT HERBARIUM
University of Waterloo, Ontario
Solidago perlonga Fernald
FAMILY Compositae - Astereae
COLL. J.C. Semple
NR. 11824
DATE 18 Sep 2009
LOCATION
U.S.A. New Jersey. Burlington Co., S of Atsion, US-206 just N of county line. 39° 43' 46.9 N, 74° 43' 50.8 W, 12 m ele.
COMMENTS
edge of pine swamp; small plants have S. stricta-like short branched inflor., tall shoots have long spreading branches
2n= 54: from transplanted rootstock, JCS.
SPECIMENS WAT(6), BRIT, GH, MO, NCU, NY
DET. JCS
Multivariate Studies in Solidago
Solidago subsect. Maritimae
Y-F. Ma & J.C. Semple Specimen No 161
WAT 2003 University of Waterloo
CHROMOSOME VOUCHER
counted by for
John C. Semple WAT
SPECIMEN CITED

Figure 5. Example of *Solidago stricta* used in the multivariate study, large shoot: *Semple 11824* (WAT).

Figure 6. Examples of *Solidago stricta* used in the multivariate study: *Semple 11824* (WAT), small shoot; insert: lower stem leaves, *Semple 11575* (WAT), large shoot, scale bar = 1 cm.

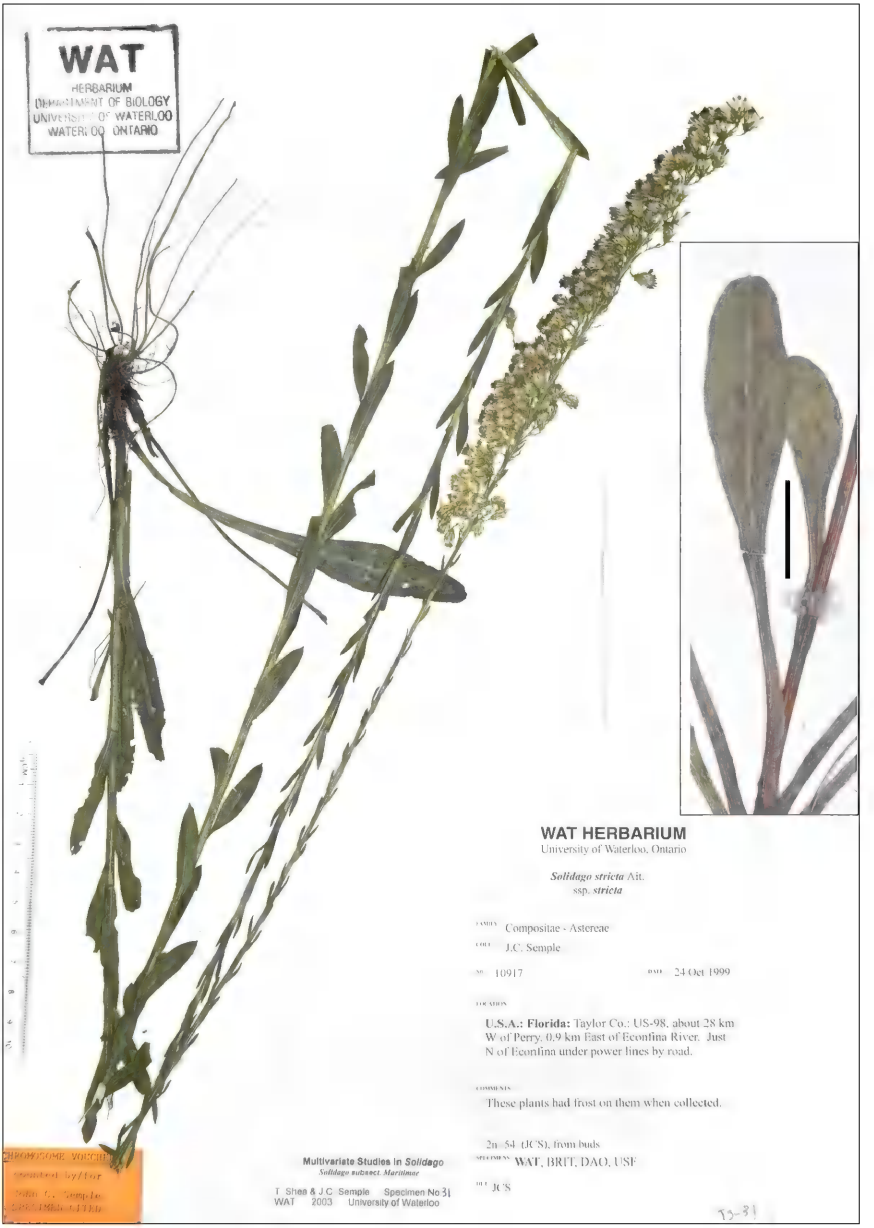
WAT
HERBARIUM
UNIVERSITY OF WATERLOO
WATERLOO ONTARIO
WAT HERBARIUM
University of Waterloo, Ontario
Solidago stricta Ait.
ssp. stricta
Compositae - Astereae
J.C. Semple
10917
24-Oct 1999
U.S.A.: Florida: Taylor Co.: US-98, about 28 km W of Perry, 0.9 km East of Econfina River. Just N of Econfina under power lines by road.
These plants had frost on them when collected.
2n=54 (JCS), from buds
WAT, BRIT, DAO, USF
JCS
Multivariate Studies in Solidago
Solidago subsect. Maritimae
T. Shea & J.C. Semple Specimen No 31
WAT 2003 University of Waterloo

Figure 7. Examples of *Solidago virgata* used in the multivariate study: *Semple 10917* (WAT), secund arrangement of heads due to stem leaning over rather than growing strictly erect; insert: lower stem leaves *Huck 1544* (NCU).

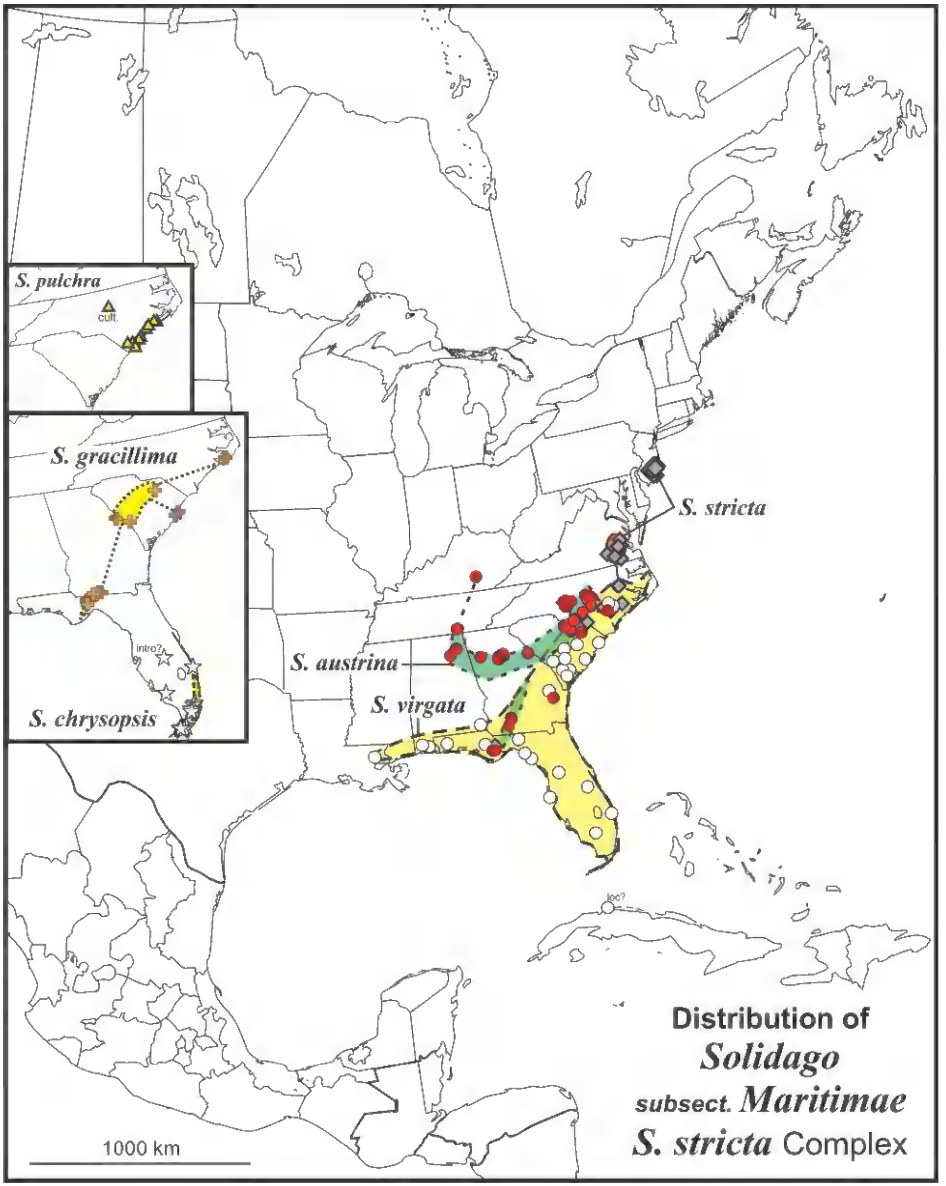

Figure 8. Distribution of the ranges and locations of multivariate samples of the species of the *Solidago stricta* complex (*Solidago* subsect. *Maritimae*): *S. austrina* (red dots), *S. chrysopsis* (white stars in insert), *S. gracillima* (light brown +s in insert), *S. pulchra* (yellow triangles), *S. stricta* (gray diamonds), *and S. virgata* (white dots).

mid length with the longest spreading and arching; he restricted *S. stricta* to outer coastal plain plants with short inflorescence branches regardless of the inflorescence size; and he recognized the Atlantic coastal plain plants of Virginia and New Jersey as *S. perlonga*, whose robust inflorescences had lower stem branches that were proximally ascending and diverging gradually away from the main axis of the inflorescence. After seeing an image of the holotype of *S. stricta*, Semple (2013) noted that the name had been misapplied to the southern race, which should be correctly labeled *S. virgata*, and that the name *S. stricta* was correctly applied to just the plants he treated as *S. perlonga* in 2012. In 2014, the first author examined the holotype of *S. stricta* at the British Museum of Natural History and confirmed his 2013 conclusion about the proper application of the name. In summary, the nomenclatural confusion about how to apply the name *S. stricta*, has been a problem for many decades and has required a combination of field observations of many populations over multiple decades, the accumulation of a large data base on chromosome number variation within the complex, and radical rethinking of how to treat the multiple ecologically distinct races occurring within the complex. Fernald's (1950) treatment of the complex would have been a better place to start than with Cronquist (1968, 1980), but Gray's Manual (8th edition) only covered the more northern members of the complex.

Semple et al. (2016) reported the results of a multivariate study of the *Solidago sempervirens* complex that includes five species. *Solidago azorica* Hochstetter ex Seubert is native in the Azores and introduced in the Bahamas and Bermuda. *Solidago mexicana* L. and *S. sempervirens* L. are native to salt marshes and coasts from Newfoundland, Canada to Tabasco, Mexico. *Solidago maya* Semple is native to wetter soils in the mountains of Chiapas, Mexico and the Maya Mountains of eastern Guatemala and western and central Belize. *Solidago paniculata* DC. is native to central Mexico in wetter areas of the Mexico City region (possibly extinct) and eastern Michoacán. Specimens of *S. maya* and eastern diploid *S. mexicana* can be similar to *S. virgata* and are included in one analysis in the study reported below.

Cytological sampling of the six species of the *Solidago stricta* complex ranges from just one known chromosome count to dozens of counts for a species. *Solidago chrysopsis* and *S. gracillima* are only known at the diploid level ($2n$ = 18; Beaudry 1963; Semple et al. 1993; unpublished data). *Solidago pulchra* is only known at the tetraploid level ($2n$ = 36; Semple et al. 1993; unpublished data). *Solidago stricta* is only known at the hexaploid level ($2n$ = 54; Beaudry 1963; unpublished data). *Solidago austrina* is known at the diploid level in the eastern and southern parts of its range and at the tetraploid level in South Carolina, northern Alabama and southcentral Tennessee ($2n$ = 18 and $2n$ = 36; unpublished data). *Solidago virgata* is known at the diploid, tetraploid and hexaploid levels ($2n$ = 18, $2n$ = 36, and $2n$ = 54; usually reported as *S. stricta*; Beaudry 1963, 1969; Semple et al. 1981, 1984, 1993; Semple and Cook, 2004; unpublished data). A manuscript on the cytogeography of all species in *S.* subsect. *Maritimae* is in preparation by J.C. Semple and R.E. Cook and will include details on the unpublished counts noted here.

A multivariate morphometric analysis of the *Solidago stricta* complex has not been previously published. Specimens of *S. virgata* were included in Semple et al. (2016). The study presented here was designed to statistically explore the following questions: (1) Overall, into how many species can the *S. stricta* complex be usefully divided? (2) What traits best separate these species? (3) What are the consequences of including small shoots with small inflorescences in the analyses? (4) How well do habitat preferences and ranges fit with the morphologically defined species?

MATERIALS AND METHODS

In total, 211 specimens selected from a much larger number of specimens of *Solidago* subsect. *Maritimae* from BRIT, F, FLAS, FSU, GH, J.K.Morton in ROM, KY, LL, MO, MT, NCU, NY, TEX, UNCC, USCH, USF, and WAT in MT (Thiers, continuously updated) were scored and included in this study. Data were scored on *S. austrina* (41 specimens; Fig. 1), *S. chrysopsis* (19 specimens; Fig. 2), *S. gracillima* 18 specimens; Fig. 3), *S. pulchra* (15 specimens; Fig. 4), *S. stricta* (34 specimens; Figs. 5-6), and *S. virgata* (30 specimens; Fig. 7) of the *S. stricta* complex and *S. maya* (9 specimens; see Semple

2018 for illustrations) and eastern and western populations of *S. mexicana* (29 and 16 specimens respectively) of the *S. sempervirens* complex. Ranges of species in the *S. stricta* complex are shown in Fig. 8 along with the locations of samples included in a priori groups the multivariate analyses. Nineteen vegetative and 19 floral traits were scored when possible: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait.

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics were used to define a priori groups along with geographic location. Basal rosette and lower stem leaf traits were not included in the analyses because these were often not present on specimens. The numbers of longer branches in the inflorescence and their proximal angle of ascent and distal amount of outward curvature were used in defining a priori groups and were not included in the matrix in the discriminant analyses.

All analyses were performed using SYSTAT v.10 (SPSS 2000). Details on the methodology are presented in Semple et al. (2016) and are not repeated here. Ten analyses were performed. In the first analysis, nine putative species level a priori were included: *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. maya*, eastern populations of *S. mexicana*, western populations of *S. mexicana*, *S. pulchra, S. stricta*, and *S. virgata*. In the second analysis, six species level a priori groups were included: *S. austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra, S. stricta*, and *S. virgata*. In the third analysis *S. gracillima* was excluded and only five species were included: *S. austrina, S. chrysopsis*, *S. pulchra, S. stricta*, and *S. virgata*. In the fouth analysis, four species were included: *S. austrina*, *S. chrysopsis*, *S. pulchra* and *S. virgata*. In the fifth analysis, *S. austrina*, *S. chrysopsis*, and *S. virgata* were included. In the sixth analysis only *S. austrina* and *S. virgata* were included. In the seventh analysis only *S. stricta* and *S. virgata* were included. In the eighth analysis only *S. chrysopsis* and *S. virgata* were included. In the nineth analysis only *S. pulchra* and *S. virgata* were included. In the tenth analysis only *S. mexicana* and *S. virgata* were included.

RESULTS

The Pearson correlation matrix yielded $r > |0.7|$ for most pairs of leaf traits reducing the number to be used to either mid leaf or upper leaf length, upper leaf width, and usually either mid leaf or upper serrations. Basal rosette leaves were often absent and were not included in the discriminant analyses. Ray floret lamina length sometimes correlated with involucre height and usually was not included in the STEPWISE analyses. Ray floret pappus length at anthesis usually correlated with disc floret pappus length and only the latter trait was included in STEPWISE analyses. Inflorescence length and width traits were generally used in defining a priori groups and were not included in the analyses.

Nine species groups analysis

In the STEPWISE discriminant analysis of nine putative species level a priori groups *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata* of the *S. stricta* complex and *S. maya* and eastern and western populations of *S. mexicana* of the *S. sempervirens* complex, the following seven traits were selected as best separating the groups and are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (15.06), number of disc florets (12.57), number of rays florets (12.42), upper leaf length (11.46), mid series phyllary width (7.91), number of nodes in distal 25% of the stem below the inflorescence (5.79), and involucre height (4.51). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of $p = 0.000$ that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 3. F-values based on Mahalanobis distances between group centroids in N dimensional hyperspace indicated the largest separations were between eastern *S. mexicana* and *S. pulchra* (25.088), *S. gracillima* and *S. virgata* (23.649), and *S. gracillima* and western *S. mexicana* (23.328), and the least separations were between *S. maya* and eastern *S. mexicana* (1.487), *S. maya* and western *S. mexicana* (3.562), and *S. austrina* and *S. gracillima* (3.695).

Table 1. Traits scored for the multivariate analyses of specimens of *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata.*

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
UPSTMNOD25	Number of nodes in distal 25% of the stem below the inflorescence
UPSTMNOD 20	Number of nodes in distal 20% of the stem below the inflorescence
BLFLN	Basal rosette leaf length measured from the leaf base to tip (mm)
BLFWD	Basal rosette leaf width measured at the widest point (mm)
BLFWTOE	Basal rosette leaf measured from the widest point to the end (mm)
BLFSER	Basal rosette leaf dentation - number of serrations along (one side)
LLFLN	Lower leaf length measured from the leaf base to tip (mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end (mm)
LLFSER	Lower leaf margin - number of serrations (one side)
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf margin - number of serrations (one side)
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end (mm)
ULFSER	Upper leaf margin - number of serrations (one side)
CAPL	Length of inflorescence (cm)
CAPW	Width of inflorescence (cm)
CAPBRLN	Length of longest lower inflorescence branches (cm)
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
OPHYLW	Outer phyllary width (mm)
IPHYLN	Inner phyllary length (mm)
IPHYLW	Inner phyllary width (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
RPUB	Density of hairs on ray floret ovary at anthesis (1-5 scale)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)
DPUB	Density of hairs on disc floret ovary at anthesis (1-5 scale)

In the Classificatory Discriminant Analysis of the nine putative species level a priori groups, a posteriori assignments of specimens ranged from 38-95% to their own group. The Classification matrix and Jackknife classification matrix are presented in Table 3. Results are presented in decreasing order of percent correct placement. Eighteen of 19 specimens of the *Solidago chrysopsis* a priori group (95%) were placed a posteriori into the *S. chrysopsis* group: 7 specimens were placed a posterior with 90-95% probability; 3 specimens with 81-86% probability, 2 specimens with 71% and 78% probabilities, 4 specimens with 63-69% probability, 1 specimen with 42% probability (26% to *S. maya* and 20% to eastern *S. mexicana*), and 1 specimen with 28% probability (23% to *S. maya*; 20% to eastern *S. mexicana*, 13% to *S. virgata*, and 10% to *S. stricta*). One specimen of the *S. chrysopsis* a priori group was assigned to *S. gracillima* with 32% probability (29% to *S. chrysopsis*; 16% to *S. austrina*; and 15% to *S. maya*). Fourteen of 15 specimens of *S. pulchra* (93%) were assigned a posteriori to the *S. pulchra* group; 12 with 92-100% probabilities, and 2 with 64% and 51% probabilities. One specimen of the *S. pulchra* a priori group was assigned to *S. maya* with 42% probability (21% to *S. chrysopsis*; 15% to *S. stricta*, 4% to *S. austrina*, and 3% to *S pulchra*). Sixteen of the 18 specimens of the *S. gracillima* a priori group (89%) plus one additional specimen were assigned a posteriori to *S. gracillima*: 6 specimens with 80-93% probability; 5 specimens with 72-77% probability, 2 specimens with 64-65% probability, and 1 specimen with 59% probability (40% to *S. austrina*) and 1 specimen with 42% probability. Three specimens of the *S. gracillima* a priori were assigned to other species. All other taxa had much lower percents of correct assignment (38-63%) and are not discussed in detail; 69% of 16 specimens for western *S. mexicana* were assigned to that group a posteriori, but only 38% of 29 specimens of eastern *S. mexicana* were assigned to that group a posteriori; 62% of the 29 specimens of *S. virgata* were assigned to that group a posteriori. Among the specimens of *S. virgata* not assigned a posterior *to S. virgata* was *Urbatsch 10776* (LSU) from Louisiana; the specimen was assigned to *S. maya* with 37% probability (15% each to *S. chrysopsis* and to *S. stricta*, 12% each to *S. virgata* and eastern *S. mexicana* and 8% to western *S. mexicana*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for 208 specimens of *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. maya*, eastern and western *S. mexicana* separately, *S. pulchra*, *S. stricta*, and *S. virgata* were not very informative due to considerable overlap in group distributions on the diagrams and are shown in Fig. 9. Only the symbols of *S. pulchra* are fairly well separated from other taxa on CAN1 versus CAN3. Eigenvalues on the first three axes were 1.882, 0.830 and 0.661.

Table 2. Between groups F-matrix for the nine putative a priori groups analysis (df = 7 193).

Group	*austrina*	*chrysopsis*	*gracillima*	*maya*	*mexicana* E	*mexicana* W	*pulchra*	*stricta*
chrysopsis	18.522							
gracillima	3.695	16.406						
maya	9.6544	4.870	9.016					
***mexicana* E**	19.311	12.273	17.474	1.487				
***mexicana* W**	13.435	14.611	23.209	3.562	4.621			
pulchra	13.367	18.466	15.740	14.032	25.088	25.177		
stricta	16.290	12.995	16.754	4.215	12.453	9.089	23.184	
virgata	21.051	11.030	23.601	7.6871	16.343	10.965	25.329	4.549

Wilks' lambda = 0.05825 df = 7 8 199; Approx. F = 12.9701 df = 56 1044 prob = 0.0000

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of nine putative a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*chrysop-sis*	*gracil-lima*	*maya*	*mexicana* E	*mexicana* W	*pulchra*	*stricta*	*virgata*	% correct
austrina	18	2	10	0	1	0	5	1	2	46
chrysopsis	0	18	1	0	0	0	0	0	0	95
gracillima	1	0	16	0	1	0	0	4	1	89
maya	0	1	1	5	0	0	0	1	0	56
***mexicana*E**	3	0	0	5	11	5	0	4	1	38
***mexicana*W**	0	1	0	1	1	11	0	0	2	69
pulchra	0	0	0	1	0	0	14	0	0	93
stricta	1	3	0	4	2	2	1	19	2	56
virgata	1	2	0	3	0	0	0	5	18	62
Totals	24	27	28	19	17	18	20	30	25	63

Jackknifed classification matrix

Group	*austrina*	*chrysop-sis*	*gracil-lima*	*maya*	*mexicana* E	*mexicana* W	*pulchra*	*stricta*	*virgata*	% correct
austrina	17	2	10	0	1	0	5	2	2	44
chrysopsis	0	17	1	1	0	0	0	0	0	89
gracillima	0	0	15	0	2	0	0	1	0	83
maya	0	1	1	5	1	0	0	1	0	56
***mexicana*E**	3	0	0	5	10	6	0	4	1	34
***mexicana*W**	0	1	0	3	3	8	0	0	2	50
pulchra	0	0	0	1	0	0	14	0	0	93
stricta	1	3	0	4	2	2	1	16	5	47
virgata	1	3	0	3	0	0	0	5	17	59
Totals	22	27	28	21	18	16	20	30	26	57

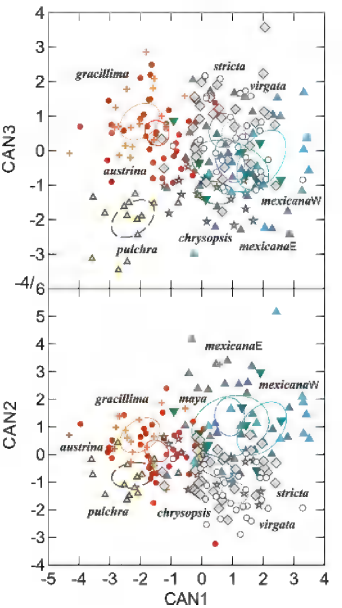

Figure 9. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 207 specimens of six a priori groups of the *Solidago stricta* complex and three a priori groups of the *S. sempervirens* complex: *S. austrina* (red dots), *S. chrysopsis* (gray stars), *S. gracillima* (orange +s), *S. maya* (green triangles), eastern *S. mexicana* (dark blue tringles), western *S. mexicana* (light blue triangles), *S. pulchra* (yellow triangles), *S. stricta* (gray diamonds), and *S. virgata* (white dots with black outline).

Six species groups analysis

In the STEPWISE discriminant analysis of 157 specimens of the six species level a priori groups *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata*, the following eight traits were selected as best separating the groups and are listed in order of decreasing F-to-remove values: length of the longest inflorescence branch (62.79), number of disc florets (18.96), disc floret pappus length at anthesis (18.80), mid leaf length (13.76), number of ray florets (8.63), involucre height (6.08), mid series phyllary width (5.52), and mid series phyllary length (4.22). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples

of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 3. F-values based on Mahalanobis distances between group centroids indicated the largest separations were between *Solidago gracillima* and *S. virgata* (68.412), *S. gracillima* and *S. stricta* (54.317), *S. chrysopsis*, and *S. gracillima* (46.400), and *S. austrina* and *S. gracillima* (46.089), and the least separations were between *S. chrysopsis* and *S. virgata* (8.205) and *S. stricta* and *S. virgata* (6.211).

Table 4. Between groups F-matrix for the six a priori group analysis (df = 8 144).

Group	*austrina*	*chrysopsis*	*gracillima*	*pulchra*	*stricta*
chrysopsis	16.4892				
gracillima	46.089	46.400			
pulchra	14.268	14.684	48.452		
stricta	20.133	12.040	54.317	23.458	
virgata	21.856	8.205	68.412	19.742	6.211

Wilks' lambda = 0.0228 df = 8 5 151; Approx. F = 21.7563 df = 40 633 prob = 0.0000

In the Classificatory Discriminant Analysis of the six species level a priori groups, a posteriori assignments of specimens ranged from 79-89% to their own group. The Classification matrix and Jackknife classification matrix are presented in Table 5. Results are presented in decreasing order of percent correct placement. Seventeen of 19 specimens of *Solidago chrysopsis* (89%) were assigned a posteriori to the *S. chyrsopsis* group; 9 specimens with 90-99% probability, 5 specimens with 80-87% probability, and 3 specimens with 70-76% probability. Two specimens of the *S. chrysopsis* a priori group were assigned a posteriori to *S. virgata* with 62% probability (19% to *S. chrysopsis* and 16% to *S. stricta*; *Correll et al. 44222* NCU from Dade Co., Florida) and 56% probability (37% to *S. chrysopsis* and 6% to *S. stricta*; *McCart 11218* USF; Martin Co., Florida; narrow basal leaves, *S. mexicana* like inflorescence but 5% probability to eastern *S. mexicana* in the first analysis). Seventeen of 19 specimens of *S. gracillima* a priori group (89%) plus one additional specimen not included in the a priori group were placed a posteriori into the *S. gracillima* group: 16 specimens with 98-100% probability; 1 specimen with 73% probability (16% to *S. austrina* and 10% to *S. stricta*); and 1 specimen with 59% probability (41% to *S. austrina*; *Smith s.n.* NCU from Darlington Co., South Carolina). Two specimens of the *S. gracillima* a priori group were placed a posteriori into *S. austrina*: 1 specimen with 96% from Florida (*Godfrey 60447* FSU with a possibly damaged inflorescence and atypical branching pattern), and 1 specimen with 62% from Florida (32% to *S. gracillima*; *Godfrey 67758* FSU with a small inflorescence without long branches). Thirteen of the 15 specimens of the *S. pulchra* a priori group (87%): all 13 with 90-100%

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of six a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*chrysopsis*	*gracillima*	*pulchra*	*stricta*	*virgata*	% correct
austrina	34	1	0	5	1	0	83
chrysopsis	1	17	0	0	0	1	89
gracillima	2	0	17	0	0	0	89
pulchra	0	1	0	13	0	1	87
stricta	0	4	0	0	27	3	79
virgata	1	1	0	0	3	24	83
Totals	38	24	17	18	31	31	84

Jackknifed classification matrix

Group	*austrina*	*chrysopsis*	*gracillima*	*pulchra*	*stricta*	*virgata*	% correct
austrina	30	1	0	5	5	0	73
chrysopsis	1	17	0	0	0	1	89
gracillima	3	0	16	0	0	0	84
pulchra	0	1	0	13	0	1	87
stricta	0	5	0	1	23	5	68
virgata	2	1	0	0	4	22	76
Totals	36	25	16	19	32	29	77

probability. Two specimens of the *S. pulchra* a priori group were assigned to other species: 1 specimen (*Kologiski 512* UNCC from Brunswick Co., North Carolina) to *S. chrysopsis* with 60% probability (14% to *S. virgata*, 13% to *S. stricta*, and 11% to *S. austrina*); and 1 specimen (*McCarthy s.n.* NCU; from Willington, North Carolina), with 41% to *S. virgata* (25% to *S. pulchra*, 14% to *S. chrysopsis*, and 12% to *S. austrina*, and 8% to *S. stricta*). Thirty-four of the 41 specimens of *S. austrina a priori group* (83%) were assigned a posteriori to the *S. austrina* group: 19 specimens with 93-100% probability, 5 specimens with 81-87% probability, 3 specimens with 70-76% probability, 3 specimens with 63-66% probability, 3 specimens with 52-55% probability, and 1 specimen with 40% probability (40% to *S. stricta*, 12% to *S. virgata* and 8% to *S. chrysospis*; *Heller 1284* NY from Rowan Co., North Carolina). Seven specimens of the *S. austrina* a priori group were assigned to other species: 4 specimens to *S. pulchra* with 45-99% probability (3 with very immature inflorescences without lower branches elongated including a tetraploid *Semple & Suripto 9782* WAT from Kershaw Co., South Carolina), 1 hexaploid specimen (*Semple & LeBlond 11788* WAT from Pender Co., North Carolina; with serrate narrow lower stem leaves) to *S. chrysopsis* with 78% probability (16% to *S. austrina*), and 1 specimen (*Radford 18716* NCU from Chesterfield Co., South Carolina) to *S. stricta* with 58% probability (41% to *S. virgata*). Twenty-four of the 29 specimens of the *S. virgata* a priori group (83%) were assigned a posteriori to the *S. virgata* group: 9 specimens with 89-96%, 2 specimens with 81% and 79% probabilities, 2 specimens with 70% and 73% probability, 9 specimens with 59-68% probability, 1 specimen with 52% probability (*Semple 11630* WAT from Pender Co., North Carolina; hexaploid; 28% to *S. chrysopsis* and 15% to *S. stricta*), and 1 specimens with 44% probability (Urbatsch 10776 from Tangipahoa Par., Louisiana; 37% to *S. stricta* and 18% to *S. chrysospsis*). Five specimens of the *S. virgata* a priori group were assigned a posteriori to the other species: 3 specimens to *S. stricta* with 51% probability (*Ahles & Leisner 33442* NCU from Cumberland Co., North Carolina; 49% to *S. virgata*); 38% probability (*Semple 11777* WAT from Orangeburg Co., South Carolina; hexaploid; 31% to *S. virgata* and 30% to *S. chrysopsis*), and 36% probability (*Wright 3602* GH from Cuba; 30% *S. chrysopsis*, and 17% each to *S. virgata and S. austrina*); 1 specimen to *S. chrysopsis* with 42% probability (*Semple & Suripto 10126* WAT from Mobile Co., Alabama; 39% to *S. stricta* and 19% to *S. virgata*); and 1 specimen to *S. austrina* with 46% probability (*Smiley s.n.* NCU from Collier Co., Florida; 25% to *S. virgata* and 15% to *S. stricta*). Twenty-seven of 34 specimens of the *S. stricta* a priori group (79%) were assigned a posteriori to the *S. stricta* group: 7 specimens with 90-100% probability, 8 specimens with 80-89% probability, 5 specimens with 71-75% probability, 3 specimens with 63-68% probability, 2 specimens with 53% and 55% probabilities, and 1 specimen with 46% probability. Seven specimens of the *S. stricta* a priori group were assigned a posteriori to two other groups, four had small inflorescences and three had larger inflorescences, two with long branches: 4 specimens to *S. chrysopsis* with 60%, 55%, 46%, and 35% probabilities; 3 specimens to *S. virgata* with 77%, 66%, and 49% probabilities.

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for 157 specimens of *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata* are presented in Fig. 10. Eigenvalues on the first three axes were 4.376, 1.683 and 0.766.

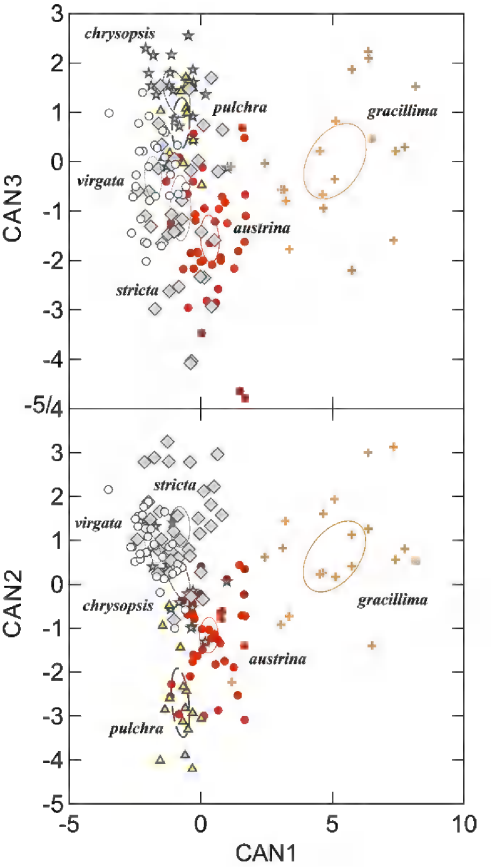

Figure 10. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 157 specimens of six a priori groups of the *Solidago stricta* complex: *S. austrina* (red dots), *S. chrysopsis* (gray stars), *S. gracillima* (orange +s), *S. pulchra* (yellow triangles), *S. stricta* (gray diamonds), and *S. virgata* (white dots).

Five species groups analysis

In the STEPWISE discriminant analysis of 138 specimens of five species level a priori groups (*Solidago austrina*, *S. chrysopsis*, *S. pulchra*, *S. stricta*, and *S. virgata*), the following seven traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (23.74), number of disc florets (22.08), mid leaf length (17.98), involucre height (7.19), mid series phyllary width (6.45), number of ray florets (5.78), and mid series phyllary length (4.77). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 6. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *Solidago pulchra* and *S. stricta* (27.556); the smallest separation was between *S. stricta* and *S. virgata* (5.194).

Table 6. Between groups F-matrix for the five a priori group analysis (df = 7 127).

Group	*austrina*	*chrysopsis*	*pulchra*	*stricta*
chrysopsis	18.355			
pulchra	15.878	15.459		
stricta	24.461	14.532	17.556	
virgata	24.739	9.009	22.640	5.194

Wilks' lambda = 0.0829 df = 7 4 133; Approx. F = 16.3141 df = 282 459 prob = 0.0000

In the Classificatory Discriminant Analysis of the five species level a priori groups, percents of correct a posterori assignment to the same a priori group ranged from 74% to 89%. The Classification matrix and Jackknife classification matrix are presented in Table 7. Results are presented in order of decreasing percents of correct placement. Seventeen of the 19 specimens of *Solidago chrysopsis* (89%)

were assigned a posteriori into the *S. chrysopsis* group; 7 specimens with 91-97% probability, 8 specimens with 81-89% probability, 3 specimens with 70-76% probability, and 1 specimen with 67% probability (29% to *S. virgata*; *vanHoek & Wargo 985* USF from Highlands Co., Florida). Thirteen of 15 specimens of the *S. pulchra* a priori group (87%) were assigned a posteriori to the *S. pulchra* group: 12 specimens with 93-100% probability, and 1 specimen with 88% probability. Two specimens of the *S. pulchra* a priori group was assigned to other species: 1 specimen to *S. chrysopsis* with 60% probability (14% each to *S. stricta*, and *S. virgata* and 10% to *S. austrina*; *Kologiski 512* UNCC from Brunswick Co., North Carolina; a tall plant for the species) and 1 specimen to *S. virgata* with 33% probability (25% to *S. pulchra*, 20% to *S. chrysopsis*, 13% to *S. austrina*, and 8% to *S. stricta*; *McCarthy s.n.* NCU from Willington, North Carolina). Twenty-four of the 29 specimens of the *S. virgata* a priori group (83%) were assigned a posteriori to the *S. virgata* group: 4 specimens with 92-95% probability, 5 specimens with 81-89% probability, 1 specimen with 74% probability, 8 specimens with 61-69% probability, and 4 specimens with 52-56% probability. Five specimens of the *S. virgata* a priori group were assigned to other species: 4 specimens to *S. stricta* with 40-70% probability and 1 specimen to *S. austrina* with 44% probability (26% to *S. virgata*, 14% to *S. stricta* and 2% to *S. chrysopsis*; *Smiley s.n.* NCU from Florida). Thirty-one of the 41 specimens of the *S. austrina* a priori group (76%) were assigned a posteriori to the *S. austrina* group: 20 specimens with 91-100% probability, 4 specimens with 85-89% probability, 4 specimens with 70-75% probability, 2 specimens with 63 % and 68% probabilities, and 1 specimens with 53% probability (37% to *S. chrysopsis*, and 7% to *S. virgata*). Ten specimens of the *S. austrina* a priori group were assigned to other species: 5 specimens to *S. stricta* with 45-57% probility; 3 specimens to *S. pulchra* with 99%, 85% and 74% probabilities; and 1 specimen to *S. chrysopsis* with 77% probability. Twenty-five of the 34 specimens of the *S. stricta* a priori group (74%) were assigned a posteriori to the *S. stricta* group: 8 specimens with 93-99% probability, 6 specimens with 81-89% probability, 2 specimens with 72% and 75% probabilities, 3 specimens with 66-69% probability, and 4 specimens with 53-57% probability, and 1 specimen with 43% probability (39% to *S. virgata* and 15% to *S. chrysopsis*). Nine specimens of the *S. stricta* a priori group were assigned to other species: 6 specimens to *S. virgata* with 49-69% probability, 2 specimens to *S. chrysopsis* with 54% and 45% probabilities, and 1 specimen to *S. pulchra* with 42% probability (23% to *S stricta*, 19% to *S. chrysopsis*, 9% to *S. austrina* and 7% to *S. virgata*).

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of six a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*chrysopsis*	*pulchra*	*stricta*	*virgata*	% correct
austrina	31	1	4	5	0	76
chrysopsis	10	17	0	0	1	89
pulchra	0	1	13	0	1	87
stricta	0	2	1	25	6	74
virgata	1	0	0	4	24	83
Totals	33	21	18	34	32	80

Jackknifed classification matrix

Group	*austrina*	*chrysopsis*	*pulchra*	*stricta*	*virgata*	% correct
austrina	31	1	4	5	0	76
chrysopsis	1	17	0	0	1	89
pulchra	0	1	13	0	1	87
stricta	0	3	1	24	6	71
virgata	2	1	0	5	21	72
Totals	34	23	180	34	29	77

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for 138 specimens of *Solidago austrina*, *S. chrysopsis*, *S. pulchra*, *S. stricta*, and *S. virgata* are presented in Fig. 11. Eigenvalues on the first three axes were 2.186, 1.049 and 0.549.

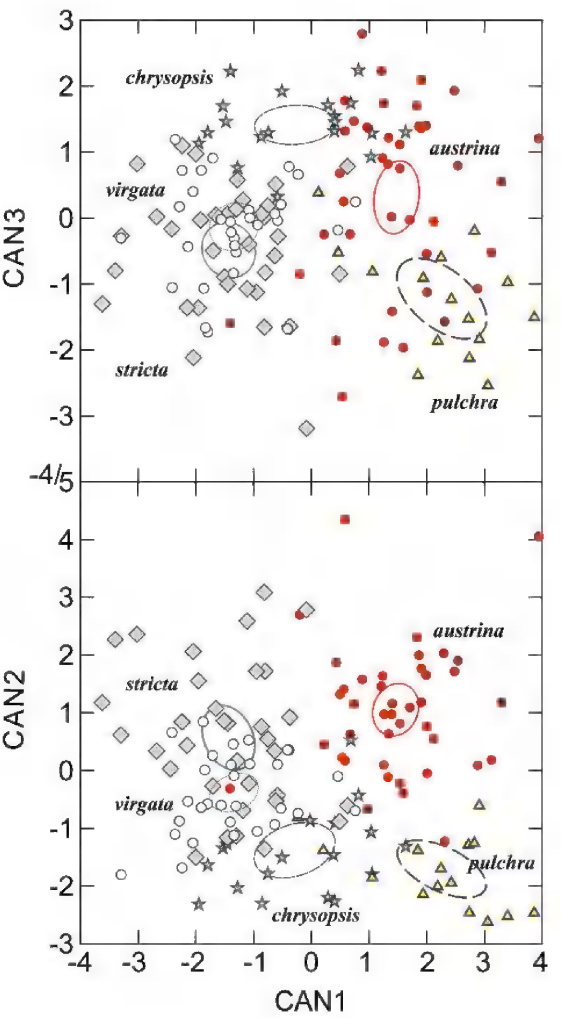

Figure 11. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 138 specimens of five a priori groups of the *Solidago stricta* complex: *S. austrina* (red dots), *S. chrysopsis* (gray stars), *S. pulchra* (yellow triangles), *S. stricta* (gray diamonds), and *S. virgata* (white dots).

Four species groups analysis

In the STEPWISE discriminant analysis of 101 specimens of four species level a priori groups (*Solidago austrina*, *S. chrysopsis*, *S. pulchra*, and *S. virgata*), the following nine traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of disc florets (3.03), upper leaf length (19.09), disc floret pappus length at anthesis (17.83), mid series phyllary width (13.79), number of mid leaf serrations (9.03), number of upper leaf serrations (8.59), number of nodes in distal 25% of the stem below the inflorescence (6.46), number of ray florets (5.88), and involucre height (4.77). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of $p = 0.000$ that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 8. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *S. pulchra* and *S. virgata* (25.881); the smallest separation was between *S. chrysopsis* and *S. virgata* (8.6281).

Table 8. Between groups F-matrix for the four a priori group analysis (df = 9 89).

Group	*austrina*	*chrysopsis*	*pulchra*
chrysopsis	19.972		
pulchra	20.989	15.540	
virgata	21.381	8.628	25.881

Wilks' lambda = 0.0484 df = 9 3 976; Approx. F= 17.5300 df = 27 260 prob = 0.0000

In the Classificatory Discriminant Analysis of the five species level a priori groups, percents of correct a posterori assignment to the same a priori group ranged from 90-100%. The Classification matrix and Jackknife classification matrix are presented in Table 9. Results are presented in order of decreasing percents of correct placement. All 19 specimens of *Solidago chrysopsis* (100%) were assigned a posteriori into the *S. chrysopsis* group; 15 specimens with 91-100% probability, 2 specimens with 82-83% probability, 1 specimen with 76% probability, and 1 specimen with 68% probability (32% to *S. virgata*; *Correll & Correll 50353* NCU from Big Pine Key, Monroe Co., Florida). All fourteen specimens of *S. pulchra* (100%) were assigned a posteriori to the *S. pulchra* group; 12 specimens with 100% probability, 1 specimen with 79%, and 1 specimen with 50% probability (45% to *S. chrysopsis* and 5% to *S. virgata*; *McCarthy s.n.* NCU from Willington, North Carolina). Thirty-four of the 39 specimens of *S. austrina* a priori group (90%) were assigned a posteriori to the *S. austrina* group; 29 specimens with 94-100% probability; 2 specimens with 80% and 86% probabilities; 2 specimens with 71% and 77% probabilities, and 1 specimens with 68% probability. Four specimens of the *S. austrina* a priori group plus 1 only included in the a posteriori classification were assigned to other species: 1 specimen, to *S. virgata* with 99% probability (*Radford 18716* NCU from South Carolina; serrate lower stem leaves; this is likely a specimen of *S. stricta*); 1 specimen to *S. pulchra* with 93% probability (*Godfrey & Fox 50299* NCU from Chatham Co., North Carolina with an atypical open few-branched inflorescence); 2 specimens to *S. chrysopsis* with 86% probability (*Semple & Leblond 11788* WAT a hexaploid from Pender Co., North Carolina,; this is likely a specimen of *S. stricta*; and *Semple 11826* WAT a diploid from Walton Co., Georgia with serrate lower stem leaves and a very immature lower inflorescence); and 1 specimen to *S. virgata* with 58% probability (39% to *S. austrina*; *Godfrey & Fox 50514* SMU in BRIT from Harnett Co., North Carolina with serrate lower stem leaves and damaged inflorescence).

Table 9. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*chrysopsis*	*pulchra*	*virgata*	% correct
austrina	35	1	1	2	90
chrysopsis	0	19	0	0	100
pulchra	0	0	14	0	100
virgata	1	2	0	26	90
Totals	36	22	15	27	93

Jackknifed classification matrix

Group	*austrina*	*chrysopsis*	*pulchra*	*virgata*	% correct
austrina	33	2	2	2	85
chrysopsis	0	19	0	0	100
pulchra	0	12	132	0	93
virgata	1	2	0	26	90
Totals	34	27	14	25	90

Two dimensional plot of CAN1 versus CAN2 canonical scores for 101 specimens of *Solidago austrina, S. stricta,* and *S. virgata* are presented in Fig. 12. Eigenvalues on the first two axes were 2.807 and 2.341.

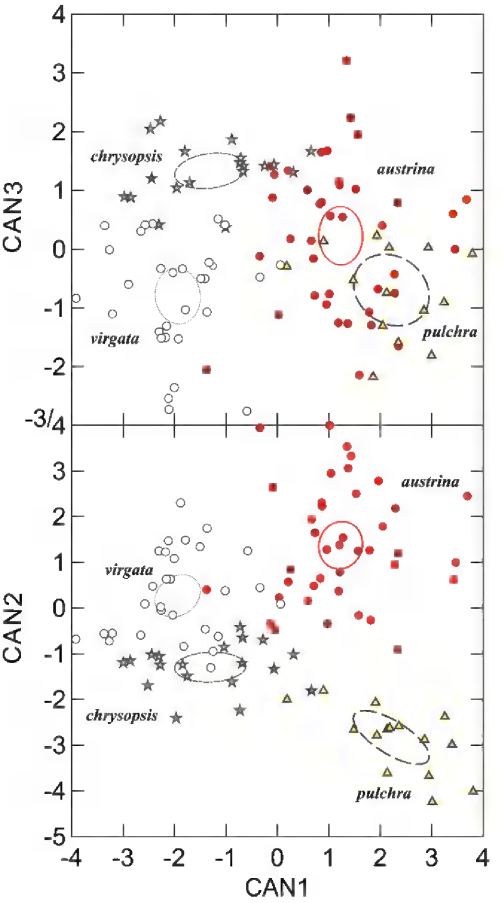

Figure 12. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 101 specimens of four a priori groups of the *Solidago stricta* complex: *S. austrina* (red dots), *S. chrysopsis* (gray stars), *S. pulchra* (yellow triangles), and *S. virgata* (white dots).

Three species groups analysis

In the STEPWISE discriminant analysis of 102 specimens of three species level a priori groups (*Solidago austrina, S. stricta,* and *S. virgata*), the following six traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (37.33), number of disc florets (11.10), number of ray florets (10.83), mid leaf width (10.09), mid series phyllary length (9.15), and involucre height (5.71). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p=0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 10. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *S. austrina* and *S. virgata* (28.729), and the smallest separation was between *S. stricta* and *S. virgata* (7.131).

In the Classificatory Discriminant Analysis of the three species level a priori groups, the percents of correct placement a posteriori ranged from 76-88%. The Classification matrix and Jackknife classification matrix are presented in Table 11. Thirty-five of 40 specimens of *Solidago austrina* (88%) plus 1 additional specimen were assigned a posteriori to the *S. austrina* group; 31 specimens were assigned with 93-100% probability and 5 specimens with 83-87% probability. Five specimens of the *S. austrina* a priori group were assigned to *S. stricta* with 59% probability (36% to *S. austrina* and 5% to *S. virgata*; *Small s.n.* NY from with serrate lower leaves and a possibly damaged inflorescence, from Stanley Co. North Carolina), 54% probability (41% to *S. austrina* and 5% to *S. virgata*; *Small s.n.* NY from Stanley Co., North Carolina), 50% probability (46% to *S. austrina* and 3% to

S. virgata; *Lindholm s.n.* GA from Liberty Co. Florida, broadly lanceolate lower stem leaves with large serrations and small inflorescence), 50%+ probability (50%- to *S. virgata*; *Radford 18176* NC from Chesterfield Co., South Carolina), and 43% probability (32% to *S. virgata* and 25% to *S. austrina*; *Heller 1284* NY from Rowan Co., North Carolina). Twenty-four of the 29 specimens of the *S. virgata* a priori group (83%) plus one additional specimen were assigned a posteriori into the *S. virgata* group; 7 specimens with 91-97% probability, 8 specimens with 81-86% probability, 8 specimens with 69-76% probability, and 1 specimen with 51% probability (*Semple & Suripto 9801* WAT from Colleton Co., South Carolina; a tetraploid with non-serrate lower stem leaves). Five specimens of the *S. virgata* a priori group were assigned to the other two species: 1 specimen to *S. austrina* with 71% probability (17% to *S. virgata* and 12% to *S. stricta*; *Smiley s.n.* NCU from Collier Co., Florida; with ovate crenate basal leaves) and 4 specimens to *S. stricta* with 66% probability (33% to *S. virgata*; *Urbatsch 10776* LSU from Tangipahoa Par., Louisiana), 64% probability (36% to *S. virgata*; *Semple & Suripto 10126* WAT from Mobile Co., Alabama with entire lower stem leaves), 64% probability (22% to *S. austrina* and 12% to *S. virgata*; *Wright 3602* GH from Cuba with entire lower stem leaves), and 52% probability (47% to *S. virgata*; *Semple 11777* WAT from Orangeburg Co., South Carolina, a hexaploid with entire lower stem leaves). Twenty-six of 34 specimens of the *S. stricta* a priori group (76%) were assigned a posteriori to *S. stricta*: 9 specimens with 91-100% probability, 5 specimens with 81-89% probability, 4 specimens with 71-75% probability (including 2 of the 6 specimens of *Semple 11824* WAT from New Jersey; a 173 cm tall shoot with a 39 cm tall long-branched inflorescence and a 97 cm tall shoot with a 29 cm tall long-branched inflorescence), 3 specimens with 61-68% probability, 1 specimen with 55% probability (45% to *S. virgata*; *Semple 11824* WAT, Fig. 5; a 94 cm tall shoot with a 33 cm tall long-branched inflorescence), 1 specimen with 53% (42% to *S. virgata* and 5% to *S. austrina; McMillan & Kjellmark 1122* NCU from Liberty Co., Florida; 125 cm tall shoot with a 24 cm tall, long-branched inflorescence), 1 specimen with 52% probability (46% to *S. virgata* and 5% to *S. austrina*; *Parker s.n.* NY from New Jersey; 81 cm tall shoot with sparsely serrate lower stem leaves and a 10 cm tall narrow inflorescence), and 1 with 44% probability (40% to *S. austrina* and 16% to *S. virgata*; *Brinton s.n.* NCU from New Jersey; 75 cm stem with serrate lower stem leaves and a 12 cm tall inflorescence with a damaged tip and 5 elongated branches). Eight specimens of the *S. stricta* a priori group were assigned a posteriori to other species: 1 specimen was assigned to *S. austrina* with 85% probability (8% to *S. stricta* and 7% to *S. virgata*; *Ahles 35961* NCU from Onslow Co., North Carolina; 125 cm tall shoot with serrate lower stem leaves and with 25 cm short-branched inflorescence); 7 specimens were assigned to *S. virgata* with 86% probability (12% to *S. stricta*; *Ahles 36278* NCU from Pender Co., North Carolina; 109 cm tall shoot with serrate lower stem leaves and an 11 cm tall short-branched inflorescence), 83% probability (17% to *S. stricta*; *Anderson 21472* FSU from Leon Co., Florida; 121 cm plus tall shoot with a 40 cm tall long-branched inflorescence; no lower stem leaves present), 76% probability (23% to *S. virgata*; *Semple 11824* WAT, Fig. 6; 48.5 cm shoot with a 12 cm short-branched inflorescence; this was a second shoot taken from the base of the 173 cm shoot listed above and placed a posteriori into *S. stricta*), 61% probability (39% to *S. stricta*; *Long 13368* GA from New Jersey; 51.5 cm tall shoot with a 5.5 cm tall short-branched inflorescence), 58% probability (42% to *S. stricta*; *Semple 11824* WAT; 135 cm tall shoot with a 29 cm long-branched inflorescence), 52% probability (47% to *S. stricta*; *Semple 11824* WAT; 84 cm tall shoot with a 16.5 cm short-branched inflorescence), and 48% probability (47% to *S. stricta* and 5% to *S. austrina*; *MacKenzie 5588* NY from New Jersey; 76 cm tall shoot with a 20 cm tall shoot branched inflorescence with immature lower branches).

Table 10. Between groups F-matrix for the four a priori group analysis (df = 6 95).

Group	*austrina*	*stricta*
stricta	27.039	
virgata	28.729	7.131

Wilks' lambda = 0.2117 df = 6 2 100; Approx. F= 18.5786 df = 12 190 prob = 0.0000

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of four a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*stricta*	*virgata*	% correct
austrina	35	4	1	88
stricta	1	26	7	76
virgata	1	4	24	83
Totals	37	34	32	83

Jackknifed classification matrix

Group	*austrina*	*stricta*	*virgata*	% correct
austrina	35	4	1	88
stricta	2	23	9	68
virgata	2	4	23	79
Totals	39	31	33	79

Two dimensional plot of CAN1 versus CAN2 canonical scores for specimens of *Solidago austrina*, *S. stricta*, and *S. virgata* are presented in Fig. 12. Eigenvalues on the first two axes were 2.276 and 0.442.

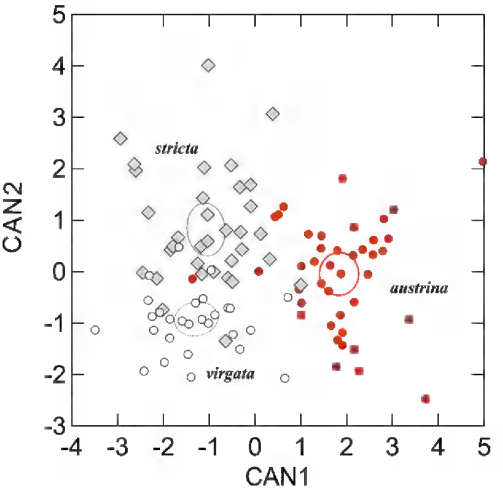

Figure 12. Two dimension plot of CAN1 versus CAN2 scores for 103 specimens in three a priori groups of the *Solidago stricta* complex: *S. austrina* (red dots), *S. stricta* (gray diamonds), and *S. virgata* (white dots).

Two species groups analysis I

In the STEPWISE discriminant analysis of 68 specimens of *Solidago austrina* and *S. virgata*, the following six traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: disc floret pappus length at anthesis (34.03), number of disc florets (18.10), number of ray florets (14.84), number of upper leaf serrations on most serrate side (6.81), upper leaf length (4.77), and number of mid leaf serrations on most serrate side (7.02). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. Group centroids of *Solidago austrina* and *S. virgata* had an F-to separate value of 30.0441 (Wilks' lambda = 0.2528, df = 6 1 66; Approx. F= 30.0441, df = 6 61 prob = 0.0000).

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori groups were 97% for *S. austrina* and 97% *S.*

virgata: one specimen of each species was assigned a posteriori to the other a priori group. The Classification matrix and Jackknife classification matrix are presented in Table 12. Thirty-eight of the 39 specimens included in the *S. austrina* a priori group (97%) were assigned a posteriori to that species: 36 specimens with 92-100% probability; 1 specimen with 88% probability (*Semple 11826* WAT from Walton Co., Georgia), and 1 specimen with 84% probability (*Godfrey & Fox 50514* SMU in BRIT from Harnett Co., North Carolina). One specimen of the *S. austrina* a priori group was assigned a posteriori to *S. virgata* with 100% probability (*Radford 18716* NCU from Chesterfield Co., South Carolina; serrate lower stem leaves). Twenty-eight of the 29 specimens of *S. virgata* a priori group (97%) were assigned a posteriori to the *S. virgata* group: 26 specimens with 93-100% probability; 1 specimen with 72% probability (*Wright 3602* GH from Cuba); and 1 specimen with 59% (*Semple et al. 3978* WAT from Sumter Co., Florida; non-serrate lower stem leaves). One specimen of the *S. virgata* a priori group was assigned a posteriori to *S. austrina* with 77% probability (*Smiley s.n.* NCU from Collier Co., Florida; this is the specimen with the ovate basal leaves with crenate margins).

Frequencies of CAN1 canonical scores for 68 specimens of *S. austrina* and *S. virgata* are presented in histograms in Fig. 13. The Eigenvalue on the first axis was 2.955.

Table 12. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*austrina*	*virgata*	% correct
austrina	38	1	97
virgata	1	28	97
Totals	39	28	97

Jackknifed classification matrix

Group	*austrina*	*virgata*	% correct
austrina	37	2	95
virgata	2	27	93
Totals	39	28	94

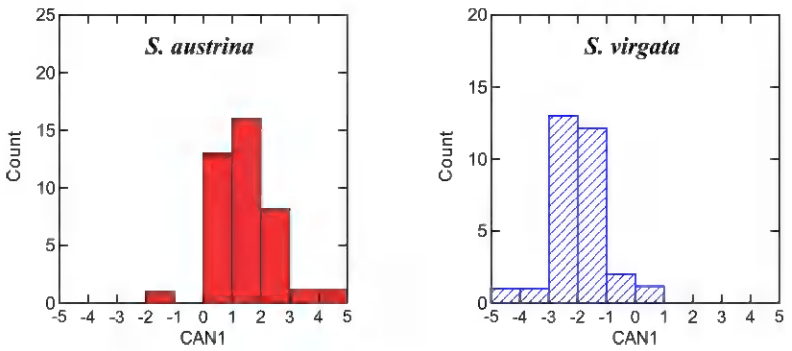

Figure. 13. Histograms of CAN1 canonical scores for 68 specimens of *S. austrina* (left) and *S. virgata* (right).

Two species groups analysis II

In the STEPWISE discriminant analysis of 64 specimens of *Solidago stricta* and *S. virgata*, the following four traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: upper leaf width (15.94), mid series phyllary length (8.82), involucre height (7.26), and disc corolla length (3.87). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. *Solidago stricta* and *S. virgata* had an F-to separate value of 12.769 (Wilks' lambda = 0.5360, df = 4 1 62; Approx. F= 12.7694 df= 4 59 prob = 0.0000).

In the Classificatory Discriminant Analysis of the two species level a priori groups *Solidago stricta* and *S. virgata*, the percents of correct placement a posteriori of specimens to the a priori group were 85% for *S. stricta* and 87% for *S. virgata*. The Classification matrix and Jackknife classification matrix are presented in Table 14. Twenty-nine of the 34 specimens of *S. stricta* (85%) were assigned a posteriori to that species: 14 specimens with 94-100% probability, 4 with 80-87% probability, 1 with 74% probability, 3 with 60-68% probability, and 7 with 52-59% probability. Five specimens of the *S. stricta* a priori group were assigned a posteriori to *S. virgata*: 1 specimen with 94% probability (*Ahles 36278* NCU from Pender Co., North Carolina with serrate lower leaves), 1 specimen with 78% probability (*Long 133368* GA from New Jersey), 1 specimen with 71% probability (*Ahles 35961* NCU from Onslow Co., North Carolina with serrate lower leaves), 1 specimen with 59% probability (*Semple 11824* WAT from New Jersey, the smallest shoot of the 6 specimen sample), and 1 specimen with 51% probability (*Semple 11824* WAT from New Jersey, the second smallest shoot of the 6 specimen sample). Twenty-six of the 30 specimens of *S. virgata* (87%) were assigned a posteriori to the *S. virgata* group: 13 specimens with 90-99% probability, 51 specimens with 81-87% probability, 1 specimen with 75% probability, 4 specimens with 65-69% probability, and 3 specimens with 53-58% probability. Four specimens of the *S. virgata* a priori group were assigned a posteriori to *S. stricta*: 1 specimen with 82% probability (*Semple & Suripto 10126* WAT from Mobile Co., Alabama, non-serrate lower leaves), 1 specimen with 81% probability (*Urtbatsch 10776* LSU from Tangipahoa Par., Louisiana, non-serrate lower leaves), 1 specimen with 75% probability (*Semple 11777* WAT from Orangeburg Co., South Carolina, hexaploid), and 1 specimen with 58% probability (*Semple et al.* 3913 WAT from Madison Co., Florida, haxaploid).

Frequencies of CAN1 canonical scores for 64 specimens of *S. stricta* and *S. virgata* are presented in histograms in Fig. 15. The Eigenvalue on the first axis was 0.866.

Table 14. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of two a priori groups; a posteriori placements to groups in rows.

Group	*stricta*	*virgata*	% correct
stricta	29	5	85
virgata	4	26	87
Totals	33	31	86

Jackknifed classification matrix

Group	*chrysopsis*	*stricta*	% correct
stricta	25	9	74
virgata	5	25	83
Totals	30	34	78

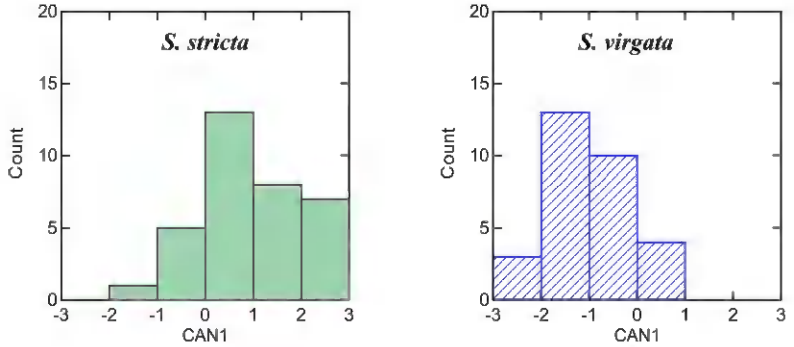

Figure. 15. Histograms of CAN1 canonical scores for 64 specimens of *S. stricta* (left) and *S. virgata* (right).

Two species groups analysis III

In the STEPWISE discriminant analysis of 44 specimens of *Solidago chrysopsis* and *S. virgata*, the following four traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-remove values: mid series phyllary width (20.01), upper leaf width (5.59), disc floret pappus length at anthesis (4.77), and the number of ray florets (4.23). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. *Solidago chrysopsis* and *S. virgata* had an F-to separate value of 23.861 (Wilks' lambda = 22.8612, df = 4 36; prob = 0.0000).

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to their a priori group were 87% for *Solidago chrysopsis* and 96% for *S. virgata*. The Classification matrix and Jackknife classification matrix are presented in Table 15. Thirteen of the 15 specimens of *S. chrysopsis* plus four additional specimens included a posteriori were assigned a posteriori to that species with 94-100% probability (including *vanHoek & Wargo* 985 USF from Avon Park Air Force Range, Highlands Co., Florida; northern most symbol on the *S. chrysopsis* insert of Fig. 8; has a non-serrate basal leaf of 174 × 5.5 mm; possibly introduced from further south around Homestead A.F.B. in Dade Co., Florida): 1 specimens was assigned with 63% probability (*Calvert s.n.* WAT from Big Pine Key, Monroe Co., Florida). Two specimens of the *S. chrysopsis* a priori group were assigned a posteriori to *S. virgata*: 1 specimen with 64% probability (*McCarthy 11218* USF from Martin Co., Florida has a basal leaf 190 × 9 mm and an inflorescence that is *S. mexicana* like in shape) and 1 specimen with 60% probability (*Correll & Correll 44222* NCU from just north of Everglades National Park, Dade Co. Florida; 2 small shoots on sheet, the right hand specimen has a mixture of basal leaves including a 120 × 10 mm leaf and a 150 × 5 mm leaf, the left hand specimen has only very narrow basal leaves; the specimen was annotated in 2011 by the first author as *"Solidago* aff. *stricta* / close to *S. chrysopsis*" but is now assigned to *S. chrysosopsis*. Twenty-five of the 26 specimens of *S. virgata* (96%) plus three additional specimens included a posteriori were assigned a posteriori to the *S. virgata* group: 23 specimens with 94-100% probability, 1 specimen with 83% probability, 1 specimen with 65% probability (*Semple 11777* WAT from Orangeburg Co., South Carolina, hexaploid). One specimen of the *S. virgata* a priori group plus one additional specimen excluded from the STEPWISE analysis were assigned a posteriori to *S. chrysopsis* with 97% probability (*Radford 42645* NCU from Hyde Co., North Carolina; has non-serrate lanceolate basal leaves, 110 × 10.2 mm), and 61% probability (*Semple et al. 3978* WAT from Sumter Co., Florida).

Frequencies of CAN1 canonical scores for specimens of *S. chrysopsis* and *S. virgata* are presented in histograms in Fig. 15. The Eigenvalue on the first axis was 2.651.

Table 15. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*chrysopsis*	*virgata*	% correct
chrysopsis	13	2	87
virgata	1	25	96
Totals	14	26	93

Jackknifed classification matrix

Group	*chrysopsis*	*virgata*	% correct
chrysopsis	13	2	87
virgata	2	24	92
Totals	15	25	90

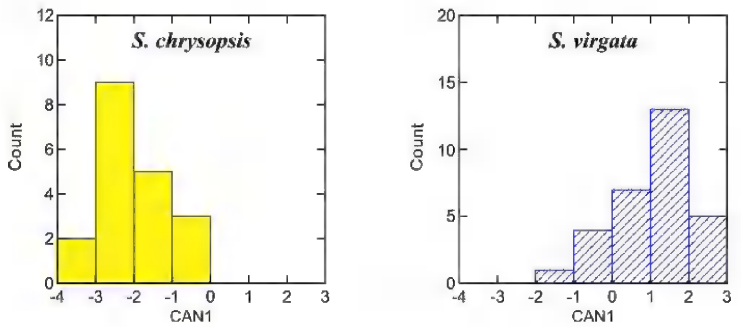

Figure. 15. Histograms of CAN1 canonical scores for 44 specimens of *S. chrysopsis* (left) and *S. virgata* (right).

Two species groups analysis IV

In the STEPWISE discriminant analysis of 44 specimens of *Solidago pulchra* and *S. virgata*, the following five traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of disc florets (45.28), disc floret pappus length at anthesis (21.55), upper leaf length (16.04), number of nodes in distal 25% of the stem below the inflorescence (8.95), and mid series phyllary length (4.62). The number of ray florets had the lowest F-to-remove value (0.07). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were samples of one group had probabilities of p = 0.001 that the null hypothesis was true. *Solidago pulchra* and *S. virgata* had an F-to separate value of 65.883 (Wilks' lambda = 0.1034 df = 5 1 42; Approx. F= 65.8832 df = 5 38 prob. 0.0000.

In the Classificatory Discriminant Analysis of 44 specimens the two species level a priori groups (*Solidago pulchra* and *S. virgata*), all 44 specimens were assigned a posteriori to their a priori group species. Thirteen of the 14 specimens of *S. pulchra* were assigned a posteriori to *S. pulchra* with 100% probability, and 1 specimen with 94% probability. All 30 specimens of *S. virgata* included in the classification analysis were assigned a posteriori to the species with 100% probability.

Frequencies of CAN1 canonical scores for 44 specimens of *S. pulchra* and *S. virgata* are presented in histograms in Fig. 16. The Eigenvalue on the first axis was 8.669.

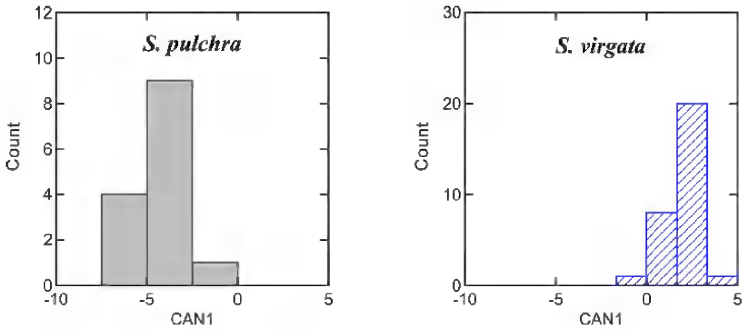

Figure. 16. Histograms of CAN1 canonical scores for 42 specimens of *S. pulchra* (left) and *S. virgata* (right).

Two species groups analysis V

In the STEPWISE discriminant analysis of 70 specimens of *Solidago mexicana* and *S. virgata*, the following six traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: upper leaf width (13.35), number of nodes in distal 25% of the stem below the inflorescence (8.70), length of ray floret pappus at anthesis (5.93), number of disc florets (5.35), length of ray floret ovary at anthesis (5.20), and number of ray florets (4.19). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. *Solidago mexicana* and *S. virgata* had an F-to separate value of 14.488 (Wilks' lambda = 0.4202 df = 6 1 68; Approx. F= 14.488 df = 6 63 prob = 0.0001).

In the Classificatory Discriminant Analysis of 70 specimens of the two species level a priori groups *Solidago mexicana* and *S. virgata*, the percents of correct placement a posteriori of specimens to the a priori group were 88% for *S. mexicana* and 89% for *S. virgata*. The Classification matrix and Jackknife classification matrix are presented in Table 15. Thirty-eight of the 43 specimens of *S. mexicana* (88%) were assigned a posteriori to the *S. mexicana* group: 30 specimens with 93-100% probability, 2 specimens with 85% and 89% probabilities, 2 specimens with 74% and 79% probabilities, 1 specimen with 67% probability, and 3 specimens with 51-59% probability. Four specimens of the *S. mexicana* a priori were assigned a posteriori to the *S. virgata* group with 96% probability (*Correll 40681* NY from Grand Bahama Is.), 54% probability (*Correll 40681* MO from Grand Bahama Is.), 51% probability (*Moreno Casasola et al. BD-1099* from Tabasco, Mexico), and 50% probability (*Lewis 7171* NY from Grand Bahama Is.). Twenty-four of the 27 specimens of *S. virgata* (89%) were assigned a posteriori to the *S. virgata* group: 18 with 91-100% probability, 2 specimens with 83-83% probability, 1 specimen with 71% probability (*Ahles 35774* NCU from Duplin Co., North Carolina {ca 60 km inland from coast}, 1 specimen with 56% probability (*Smiley s.n.* NCU from Collier Co., Florida; basal leaves are broadly ovate and crenulate but not serrate). Three specimens of the *S. virgata* a priori group were assigned a posteriori to *S. mexicana* with 88% probability (*Semple 11630* WAT from Pender Co., North Carolina; basal leaves entire, hexaploid 2*n*=54; ca. 25 km from coast roughly in line with *Ahles 35774* NCU from further inland), 60% probability (*Darst* 113 NCU from Pinellas Co., Florida; wet open slash pine woods on barrier island), and 52% probability (*Urbatsch 10776* LSU from Tangipahoa Par., Louisiana).

Table 15. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*mexicana*	*virgata*	% correct
mexicana	38	5	88
virgata	3	24	89
Totals	41	29	88.5

Jackknifed classification matrix

Group	*mexicana*	*virgata*	% correct
mexicana	34	9	79
virgata	5	22	81
Totals	39	31	80

Frequencies of CAN1 canonical scores for 70 specimens of *S. mexicana* and *S. virgata* are presented in histograms in Fig. 18. The Eigenvalue on the first axis was 1.380.

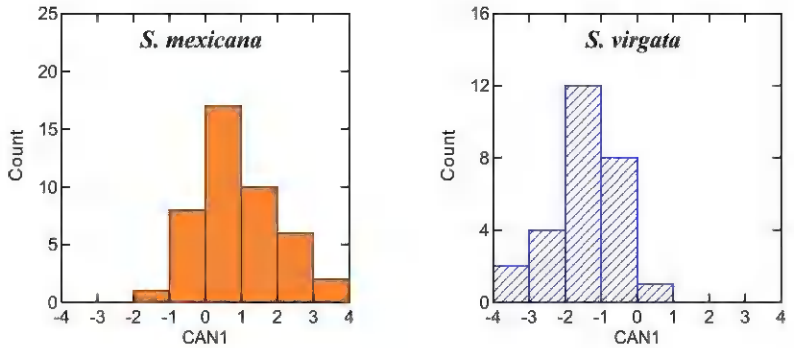

Figure. 18. Histograms of CAN1 canonical scores for 70 specimens of *S. mexicana* (left) and *S. virgata* (right).

DISCUSSION

The results of the multivariate analyses support the recognition of *Solidago austrina*, *S. chrysopsis*, *S. gracillima*, *S. pulchra*, *S. stricta*, and *S. virgata* as separate species. As noted in Semple et al. (2016), the ecological species concept is particularly useful in dealing with *Solidago* taxa (Peirson et al. 2012). As unpublished results became available over the past decade which supported splitting the *S. stricta* complex into multiple species occurring in different habitats and as unpublished and published results from other subsections of *Solidago* also began to indicate the same conclusion, the real problem in *Solidago* taxonomy was recognized: there had been too much lumping of distinct species in *Solidago* by Cronquist (e.g. 1980). Each species will be discussed below in alphabetical order.

Solidago austrina

Confusion in separating *Solidago austrina*, *S. stricta*, and *S. virgata* is understandable and complicated by multiple ploidy levels known in *S. austrina* (2x, 4x) and *S. virgata* ((2x, 4x, 6x). *Solidago austrina* occurs in Piedmont and Fall Line moist soil habitats from central North Carolina to north central Georgia, where the range bifurcates in east central Georgia and heads southwest in a narrow zone to the

hills around Tallahassee, Florida, and northwest into northeastern Alabama then north into southern Tennessee and disjunct to southern Kentucky (Fig. 8). A few collections come from the Coastal Plain in North Carolina and Georgia. *Ahles 36276* (NCU) was placed a posteriori into *S. austrina* with 83% probability and is from Pender Co., North Carolina. *Bozeman 1962* (GA) was placed a posteriori into *S. austrina* with 97% probability and comes from Long Co., Georgia. The probabilities of a posteriori placement into *S. stricta* were only a few percent in each case. Thus, sometimes *S. austrina* gets onto the coastal plain, but only rarely and possibly does not establish itself in this atypical habitat. *Lazor 4587* (MT) from Liberty Co., Florida, was placed a posteriori into *S. austrina* with 100% probability. *Lindholm s.n.* (GA) also from Liberty Co., Florida, was placed a posteriori into *S. austrina* with 46% probability (50% probability to *S. stricta*; the inflorescence is small and appears to be damaged). The ploidy level of these Florida collections is unknown. *Solidago austrina* is diploid in nearby and north central Georgia and northeast through South Carolina and North Carolina. One tetraploid from South Carolina has been found in the eastern portion of the range.

Plants of *Solidago austrina* in northern Alabama and adjacent Tennessee are tetraploids. *Semple & B. Semple 11203* (WAT and unmounted; from Cherokee Co., Alabama), *Semple & B. Semple 11198* (WAT; from Etowah Co., Alabama) were all placed a posteriori into *S. austrina* with 100% probability. *Semple et al.* 11857 (WAT) from Coffee Co., Tennessee, was assigned a posteriori to *S. austrina* with 96% probability in the three species analysis. *Campbell s.n.* (KY; Pulaski Co., Kentucky) was assigned a posteriori to *S. austrina* with 100% probability; this was originally identified as *S. uliginosa*; the ploidy level is unknown, but if the Kentucky population is disjunct from Tennessee or northeastern Alabama, then it is likely also tetraploid. Generally, even tall plants of *S. uliginosa* have fewer stem leaves that plants of *S. austrina*. Inflorescencences of southern *S. uliginosa* plants can be similar to those of *S. austrina* in having spreading and curved lower branches.

Solidago chrysopsis

Solidago chrysopsis has previously been ignored for the most part and treated as a synonym of *S. stricta* auth. non Ait. (i.e., *S. virgata*), e.g., Semple and Cook (2006). The species is a late-blooming goldenrod with very narrow lower stem leaves and a small inflorescence similar to that of *S. virgata*. It occurs in the Florida Keys and extreme southeastern Florida and in a few scattered locations further north in the Florida peninsula, which may be chance introductions (*S. chrysopsis* insert in Fig. 8). Statistical support for recognizing *S. chrysopsis* was strong in the five species analysis with 100% placement of all specimens of *S. chrysopsis* a priori group into *S. chrysopsis* a posteriori. In the two species analysis with *S. virgata*, two specimen of each species were assigned a posteriori to the other species. Based on the distribution of the specimens and the small number of technical characters selected in the STEPWISE analysis to separate the two species group centroids in N-dimensional hyperspace, all four specimens seem likely to belong to their respective a priori groups. *Solidago chrysopsis* can be confused with narrower-leaved small specimens of *S. virgata* where the ranges of the two species are sympatric in south Florida. Only one diploid chromosome count is known for *S. chysopsis*. Only diploids are known in *S. virgata* from southern Peninsula Florida.

Solidago gracillima

Solidago gracillima can be one of the most distinctive species in the field due to its sparsely, but long branched inflorescence and very reduced mid and upper stem leaves. As delimited here, the range of *S. gracillima* extends from northern South Carolina to near Tallahassee in Panhandle Florida (Fig. 8). The greatest confusion with the species has been in the misapplication of the name, as was done in Semple & Cook (2006).

A possible collection from Carteret Co., North Carolina (*Angerman s.n.* USF; the one symbol for the species in North Carolina in Fig. 8) was included in the *Solidago gracillima* a priori group in the six species analysis and was placed a posteriori in that species with 98% probability, but it was annotated as

S. aff. *gracillima* in 2012 by the first author. This specimen represented a small number of collections from North Carolina that were identified by others as *S. gracillima* but that do not appear to be the same species as all other collections included in the analyses. The specimen was included in the analyses to see where it would be placed a posteriori; it was placed a posteriori in *S. gracillima* because of its long inflorescence branches. The leaves are less reduced upward than usual in the species and the arrangement of long branches in the inflorescence is not identical to specimens in South Carolina, Georgia, and Florida. Whether or not these plants are hybrids between *S. virgata* and other species of *Solidago* is unknown. Further research is needed to determine the correct identity of this small group of specimens that, in conclusion, are not *S. gracillima*, including *Angerman s.n.* (USF).

Solidago pulchra

Solidago pulchra was well separated in the analyses from *S. virgata.* Although the species has not historically always been recognized as distinct from *S. virgata* (i.e., *S. stricta* authors non Ait. in the literature, e.g., Radford et al. 1968, Cronquist 1968), Cronquist (1980) did recognize *S. pulchra* as distinct, based on its higher numbers of ray and disc florets, as did Semple and Cook (2006). *Solidago pulchra* is tetraploid and endemic to a narrow band of sphagnum depressions away from the coast in the southern coastal counties of North Carolina (*S. pulchra* insert in Fig. 8); our sample included one specimen cultivated at the North Carolina Botanical Garden on the Piedmont. No collections have been seen from South Carolina. *Solidago pulchra* is the only species to be well separated from the other eight species included in the first analysis of nine species. In the two species analysis including *S. pulchra* and *S. virgata,* all specimens were assigned a posterior to their a priori group species with 100% probability with the exception of one specimen of *S. pulchra* assigned with 94% probability. The involucres of *S. pulchra* are more broadly cylindrical than those of *S. virgata* and this was used in defining a priori groups. The mean number of disc florets was 15 for *S. pulchra* and 7.6 for *S. virgata.* This explains the difference in involucre shape because more receptacle area is needed to accommodate the much higher number of disc florets in *S. pulchra.* Shoots and lower stem leaves of *S. pulchra* tend to be much shorter than those of *S. virgata* but the most robust shoots of the former could cause possible confusion in identification.

Solidago stricta

Historically, true *Solidago stricta* Ait. non auth. has only recently been recognized as a species separate from *S. virgata* (as *S. stricta* auth. not Ait. in much of the literature). Semple (2013) reviewed the misapplication of the name to plants now treated either as *S. uliginosa* Nutt. or as *S. virgata.* The type of *S. stricta* Ait. is a European garden-grown specimen of North American origin. Eastern Virginia seems a likely source. Fernald (1938) described *S. perlonga* as a segregate of the *S. virgata* complex (referring to group as *Solidago* sp.-group *Uliginosae* Mackenzie in Small) native to southeastern Virginia and compared it to *S. austrina, S. flavovirens* Chapm. (a synonym of *S. austrina*), and *S. yadkinensis* (Porter) Small (= *S. austrina* × *S. arguta* Ait. *var. carolininana* A. Gray) and concluded it was most similar to *S. austrina.* Fernald also noted that his *S. perlonga* bloomed later than *S. austrina,* in contrast to the usual pattern of more northern plants blooming earlier than more southern plants. The explanation for the difference in phenology is likely that *S. austrina* is diploid and rarely tetraploid, while *S. stricta* is hexaploid. In *Solidago*, polyploid races tend to bloom later than diploids, e.g., *S. canadensis* L. versus *S. altissima* L. var. *altissima* at any particular location where the two are sympatric. The New Jersey plants of *S. stricta* sensu authors also belong with Fernald's species in *S. stricta* Ait. non auth. The range is more extensive than previously thought (Fig. 8), as noted below.

Six specimens representing 5 individuals of *Semple 11824* (WAT) from a single population in Burlington Co., New Jersey, were included in the analyses in the *Solidago stricta* a priori group; these all had serrate lower stem leaves but differed greatly in stem height, inflorescence height, and inflorescence lower branch length. Probabilities of placement into *S. stricta* ranged from 25-75% (75%-25% to *S. virgata*). One of the small shoots placed a posteriori into *S. stricta* was taken from the base of a large

shoot that was placed into *S. stricta*; both shoots were from the same individual. One chromosome count of $2n = 54$ from a transplanted rootstock was obtained but cannot not be assigned to an individual voucher. These results clearly demonstrate the problem with identifying small shoots of *S. stricta* because such specimens lack an inflorescence large enough to allow lower inflorescence branches to bolt into the characteristic length and diverging pattern observed in larger specimens. If a specimen is hexaploid and has mid and lower stem leaves with serrations, then it is most likely *S. stricta*. Regrettably most herbarium collections do not include chromosome count data for the individual sampled.

The results of this study and final conclusions on identifications indicate that *Solidago stricta* Ait. non auth. occurs in North Carolina and South Carolina on the coastal plain and possibly further south. *Semple & LeBlond 11788* (WAT) is a hexaploid with serrate lower stem leaves from Pender Co., North Carolina, and is treated here in conclusion as *S. stricta* but was included in the *S. austrina* a priori group and placed in that group a posteriori in the three species multivariate analysis (*S. austrina*, *S. stricta,* and *S. virgata*). In the field at the time of collecting, Richard LeBlond suggested the possibility that a second collection from the same site (*Semple & LeBlond 11787* WAT; a hexaploid without serrations and past bloom thus not included in the analysis but treated here as *S. virgata*) and the blooming collection *Semple & LeBlond 11788* (WAT) were not the same species. He was correct because *11788* is most likely *S. stricta*. Another collection (*Radford 41611* NCU from Pitt Co., North Carolina) was included in *S. stricta* in the three species multivariate analysis and had 71% probability a posteriori of being *S. stricta* (28% probability of being *S. virgata*). *Ahles & Leisner 32434* NCU from Pender Co., North Carolina, was included in the *S. stricta* a priori group and was placed a posteriori into *S. stricta* with 81% probability in the three-species analysis. *Radford 18716* (NCU) from Cash, Chesterfield Co., South Carolina was included in the *S. austrina* a priori group because it had serrate lower and mid stem leaves but was placed a posteriori in *S. virgata* with 55% probability and *S. stricta* with 45% probability. Cash appears to be a low area south of Cheraw, South Carolina at the upper edge of the coastal plain along the "Fall Line", although it is no longer labeled as a separate community in GoogleEarth™. With very limited a posteriori probability of *Radford 18716* (NCU) being *S. austrina*, the serrate leaves indicate it to be *S. stricta*. No collections of *S. stricta* were seen from Georgia, but *McMillan & Kjellmark 1122* NCU from Liberty Co., Florida, appears to be *S. stricta* as well and has the lower long inflorescence branches of the species, but with ambivalent a posteriori probability in the analyses. Thus, it appears that hexaploid *S. stricta* occurs rarely from southern New Jersey south to Panhandle Florida, following the inner coastal plain margin. Finding *S. stricta* in Georgia will be a challenge because confirmation will depend on determining that any individual from the inner coastal plain with serrate lower stem leaves is hexaploid. Finding a particularly robust individual with a large long-branched blooming inflorescence later in the season would be ideal. Confirming the presence of *S. stricta* in the Tallahassee area of Florida should also involve determining the ploidy level of possible individuals to be hexaploid.

Solidago virgata

All specimens of *Solidago virgata* included in the multivariate analysis had non-serrate lower stem leaves and inflorescences with short lower branches regardless of the length of the inflorescence array. All specimens of *S. virgata* came from the coastal plain from North Carolina south to Florida and likely west to eastern Louisiana (Fig. 8). Lower stem leaves are petiolate with lanceolate or oblanceolate blades, but can be narrowly so.

The identity of *Smiley s.n.* (NCU) from Collier Co., Florida, is uncertain because the basal stem leaves are ovate to very broadly lanceolate and crenate but not serrate. Such leaves are very atypical for *Solidago virgata*, but the inland Collier Co. location is well out of the range of other species in the *S. stricta* complex into which it might be placed. It was included in the *S. virgata* a priori group in the analyses but usually was placed into *S. austrina* or a mixture of taxa. The plant is not a specimen of *S. austrina*. It is treated here as *S.* aff. *virgata* for lack of a better solution. From the lower mid stem to the tip of the inflorescence, the specimens looks like *S. virgata*. This is not the only hard to place one-of-a-

kind specimen of *Solidago* encountered in herbaria by the first author. Additional data of some kind is needed in this case.

Only one possible specimen of *Solidago virgata* from Louisiana was included in the analyses (*Urbatsch 10776* LSU from Tangipahoa Par.). Although *S. virgata* (under the name *S. stricta* auth. not Ait.) has been reported from Louisiana, there is very little evidence that it occurs in the state. All collections seen by the first author that were identified as *S. virgata* have turned out to be *S. mexicana*, with the exception of *Urbatsch 10776* (LSU), which is similar to specimens of *S. virgata* from southern Alabama and Panhandle Florida. The overall appearance of the specimen fits well with specimens treated here as *S. virgata*, but the results of the nine a priori groups analysis that included *S. mexicana* are inconclusive as to the probable identify of the specimen. As well, *Urbatsch 10776* (LSU) was placed a posteriori into *S. stricta* in the five-species and three-species analyses with low probabilities, and into *S. stricta* with 81% probability in the two-species analysis with *S. virgata*. Of note, a J.K. Morton & J. Venn collection of *S. virgata* from Mobile Co., Alabama, was hexaploid (unpublished data), as were collections of *S. virgata* from Walton Co., Bay Co., and Wakulla Co., in Panhandle Florida (Semple et al. 1993; unpublished data). Thus, it may be that the *Urbatsch 10776* (LSU) is also hexaploid and the multivariate analyses indicates that hexaploids in *S. virgata* are often assigned a posteriori to the hexaploid species *S. stricta*, even though these plants do not have serrate lower stem leaves. Finding hexaploid plants without lower leaf serrations in Louisiana (and southern Mississippi) would confirm the presence of the species in these states. *Urbatsch 10776* (LSU) is certainly not *S. stricta* morphologically.

In conclusion, the *Solidago stricta* complex is best treated as a group of six morphologically similar species occurring in different, but wetter soil habitats of the coastal plain and outer Piedmont from New Jersey to western Florida and adjacent states, with the range of Piedmont species *S. austrina* sweeping around the southern Appalachians into north Alabama and adjacent Tennessee and disjunct to southern Kentucky. The final statement in Semple et al. (2016) is repeated here: "Like members of other species complexes in *Solidago*, some difficulty in identifying some collections to species is to be expected. While the multivariate analyses reported here have led to a much better understanding of the complex, they do not provide a 100% fool proof solution to the challenges of identifying goldenrods in the complex."

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ON *SOLIDAGO SIMPLEX* (ASTERACEAE: ASTEREAE): A MULTIVARIATE STUDY INCLUDING *S. GLUTINOSA*, *S. LEIOCARPA*, *S. MULTIRADIATA*, AND *S. SPATHULATA*

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ABSTRACT

Solidago simplex from the Sierra Madre Oriental of Mexico is included in a multivariate study with *S. glutinosa* and *S. spathulata* of subsect. *Humiles* and *S. leiocarpa* and *S. multiradiata* of subsect. *Multiradiatae* in order to assess statistical support for recognizing *S. simplex* as a separate species from *S. glutinosa* of the Rocky Mts and Great Plains and westerm boreal forest east to disjunct areas in Michigan and Ontario. *Solidago simplex* is statistically distinct and intermediate in a number of traits between *S. glutinosa* and *S. multiradiata*. The analyses indicate that *S. glutinosa*, *S. simplex,* and *S. spathulata* (subsect. *Humiles*) and *S. leiocarpa* and *S. multiradiata* (subsect. *Multiradiatae*) should be recognized as species.

Solidago simplex Kunth (Nov. Gen. 103. 1818; Figs. 1-2) was described from a collection from northeastern Mexico nearly two centuries ago:

TYPE: **MEXICO**. **Nuevo León**. Santa Rosa "Crescit prope pagum Sanctae Rosae mexicanorum," *Bonpland & von Humboldt 1300* (holotype: P, fiche!, digital image jSTOR!).

Application of the name *S. simplex* has varied considerably in floristic treatments. For much of the time, plants from Canada and the USA were treated under multiple species names that all belong in synonymy under *S. glutinosa* Nutt. (Fig. 3), *S. spathulata* DC. (Fig. 4), or *S. simplex*, depending upon whether or not Nesom (1989) was correct in lumping the Canadian, USA, and Mexican plants (Fig. 5) into a single species occurring from Hidalgo, Mexico, to Alaska in the mountains and east to Michigan and northwestern Ontario and whether or not *S. spathulata* native to the California and Oregon coast is included in the lumping. After *S. simplex, S. spathulata* DC. is the next oldest valid name: Prodr. 5: 339. 1836; *Solidago simplex* Kunth var. *spathulata* (DC.) Cronquist (Intermountain Fl. 5: 244. 1994):

TYPE: **USA**. **California**. Probably Monterey peninsula, *Haenke s.n.* (holotype: G-DC!; isotype?: P digital image jSTOR!).

Solidago glutinosa Nutt. follows is the next oldest valid name: Trans. Amer. Phil. Soc. n.s. 7: 328. 1841. *Solidago glutinosa* var. *glutinosa* (Nutt.) Cronq., Rhodora, 49: 76. 1947; *Solidago spathulata* subsp. *glutinosa* (Nutt.) Keck (Aliso 4: 104. 1958):

LECTOTYPE (Ringius, Taxon 35: 155. 1987): **USA**. [**Oregon**]. "On the Oregon and Wahlemet rivers," *Nuttall s.n.* (BM!); isolectotype: (PH!).

Solidago stricta Hook. (Fl. Boreali-Amer. 2: 4: 1834; non Ait. 1763, nec Moench 1802, nec Less. 1831) and *S. confertiflora* DC. (Prodr. 5: 339. 1836; non Nutt. 1836, non Fisch. & Mey. 1841. *Solidago virgaurea* L. var. *confertiflora* (DC.) Kurtz (Engl. Bot. Jahrb. 19: 386. 1894):

TYPE: **CANADA**. **British Columbia**. "Nootka" Sound on Vancouver Is., *Haenke s.n.* (holotype: G-DC!). — these two are not valid names.

The names *Solidago decumbens* Greene (Pittonia 3: 161. 1897), *S. aureola* Greene (Pittonia 4: 236. 1901), *Solidago aureola* Greene (Pittonia 4: 236. 1901), *S. yukonensis* Gandoger (Bull. Soc. Bot. France 50: 214. 1903), and *S. vespertina* Piper in Piper & Beattie (Fl. Northw. Coast. 365. 1915) have all been applied to specimens of *S. glutinosa* as treated here. Cronquist (1947) lumped *S. gillmanii* (Gray) Steele, *S. racemosa* Greene, and *S. randii* (Porter) Britt. as varieties in *S. glutinosa* subsp. *randii* (Porter)

Figure 1. Example of *Solidago simplex* used in the multivariate study: *Beaman 2736* (GH).

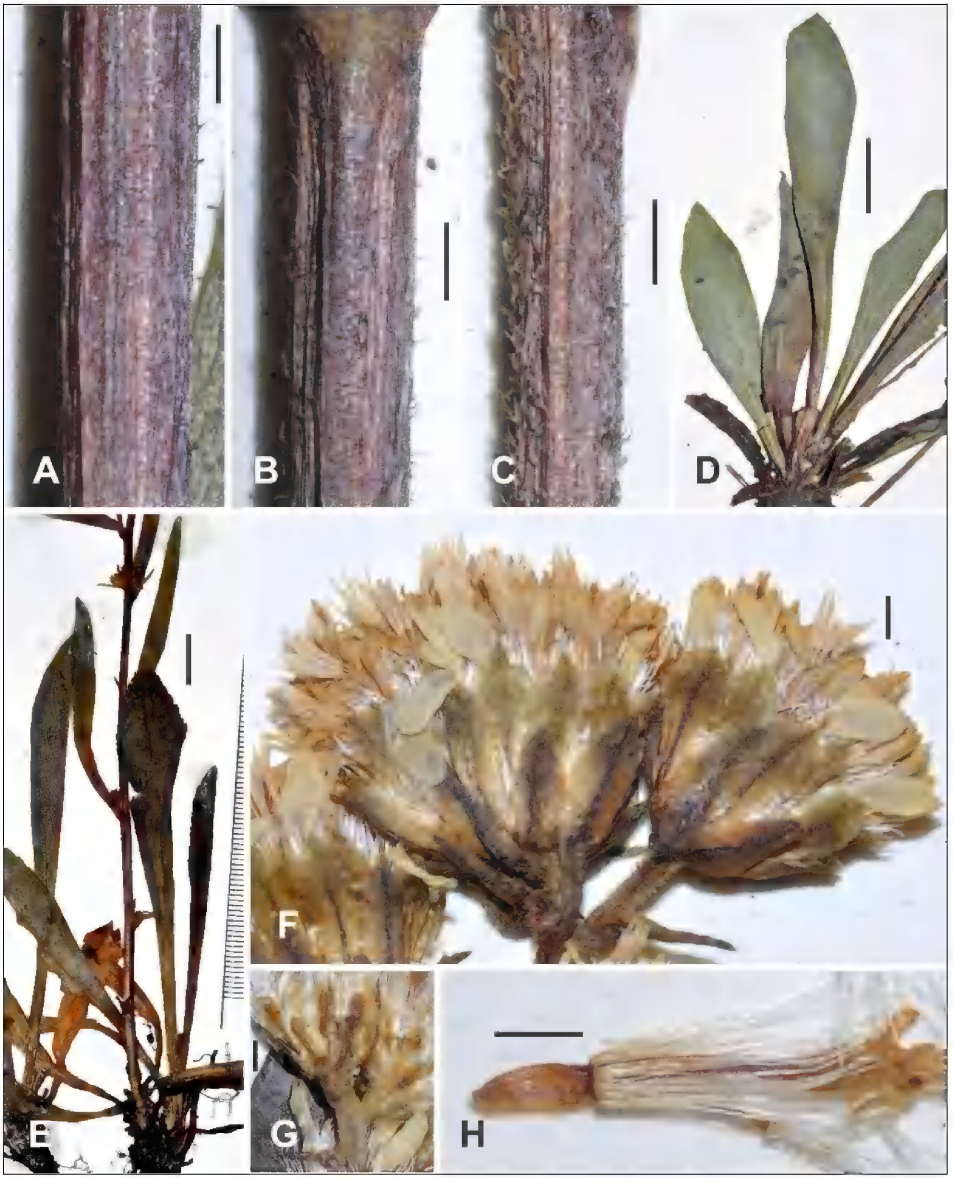

Figure 2. Details of morphology of *Solidago simplex*. **A-D.** *Beaman 2736* (GH). **A-C.** Lower, mid and upper stems. **D.** Basal rosette and lower stem leaves. **E.** Rosette and stem leaves, *Stanford et al. 2552* (TEX). F. Flowering heads, *Díaz-Barriga 6890* (TEX). G. Peduncle and phyllaries, *Hinton 22298* (TEX). H. Disc floret slightly past anthesis, *Roe et al. 247* (TEX). Scale bar = 1 cm in D and E; = 1 mm in A-C and F-H.

Figure 3. Examples of *Solidago glutinosa* used in the multivariate study: *Semple et al. 9370* (WAT unmounted): Insert A. Upper stem, *Semple & Brouillet 4218* (WAT). Insert B. Main stem, peduncle and head, *Semple & Brouillet 4218* (WAT). Scale bar = 1 mm in A-B.

Figure 4. Example of *Solidago spathulata* used in the multivariate study: *Ringius 1491* (WAT in MT); insert shows a peduncle and phyllaries with thick shiny resin.

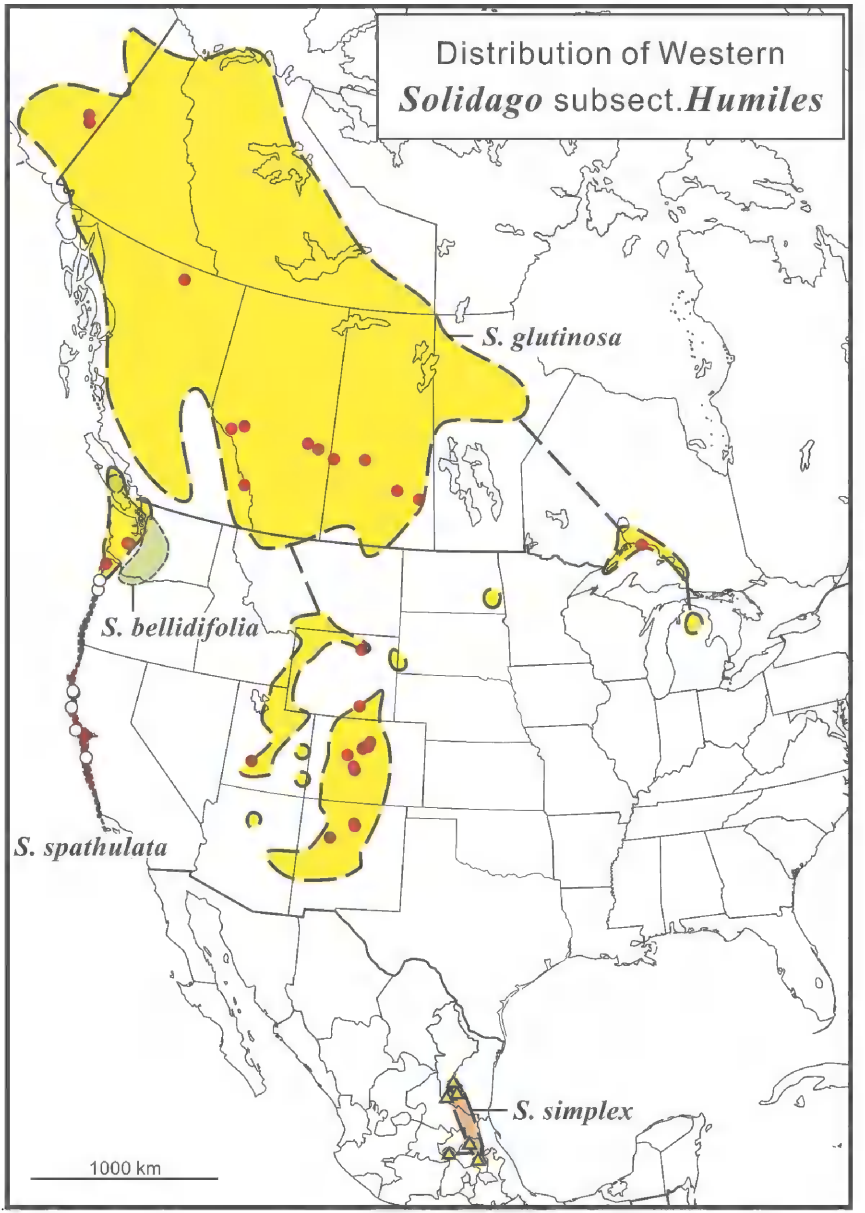

Figure 5. Distribution of the ranges and locations of multivariate samples of *Solidago simplex* (yellow triangles), *S. glutinosa* (red dots), and *S. spathulata* (white dots) of *Solidago* subsect. *Humiles*. *S. bellidifolia* was not included in the study.

Cronquist and treated *S. bellidifolia* Greene as *S. glutinosa* (subsp. *glutinosa*) var. *nana* (Gray) Cronquist. Hitchcock and Cronquist (1955) treated the western plants as varieties in *S. spathulata* DC., as did others (e.g. Welsh & Moore 1973; Welsh 1974). Ringius (1985) and Ringius and Semple (1987) followed Cronquist's (1947) application of *S. glutinosa*. Nesom (1989) placed *S. glutinosa* in synonymy under *S. simplex*. Semple and Cook (2006) followed Nesom in treating the western plants as *S. simplex* (subsp. *simplex*). In their cytogeographic study of subsect. *Humiles* (Rydb.) Semple, Peirson et al. (2012) followed Semple and Cook (2006). Semple and Peirson (2013) split the subspecies and varieties out of *S. simplex* into six species with var. *nana* retained at that level in *S. simplex*. When the first author of this paper saw the digital image of the holotype of *S. simplex* posted on line by jStor, he was not certain that the name applied to Canadian and USA plants covered in Flora North America (Semple & Cook 2006) or in Semple and Peirson (2013).

Polyploidy is known to occur in three of the five species included in this study. *Solidago glutinosa* is diploid $2n = 18$ throughout its range from Alaska to California and Arizona and east to Ontario (Beaudry & Chabot 1959; Mulligan et al. 1972; Hartman 1977; Keil & Pinkava 1979; Semple et al. 1981; Ward & Spellenberg 1986; Ringius & Semple 1987; Semple et al. 1992; Semple et al. 2001; Peirson et al. 2012) but includes some tetraploids in northern Michigan (Peirson et al. 2012). *Solidago leiocarpa* DC. (Fig. 6) is known only at the tetraploid level $2n = 36$ (Beaudry 1963; Morton 1981; unpublished counts). *Solidago multiradiata* Ait. (Fig. 7) is known at the diploid level 2n = 18 throughout most of its range (Fig. 8) from Alaska south to California, Arizona and New Mexico and east to Newfoundland (Ward & Spellenberg 1968; Solbrig et al. 1969; Morton 1981; Löve & Löve 1982a; Semple et al. 1984; Semple & Chmielewski 1987; Semple et al. 2001; numerous unpublished counts) and as tetraploids from eastern Siberia south to Wyoming and east to Ontario (Zhukova & Tikhonova 1971; Witherspoon et al. 1974; Dawe & Murray 1979, 1980, 1981; Chinnappa & Chmielewski 1987; unpublished counts). Only diploids have been reported in *S. spathulata* (Raven et al. 1960; Beaudry 1969; Ringius & Semple 1987; Semple et al. 1989). No chromosome number has been reported the Mexican *S. simplex*.

A multivariate study has not been published previously on plants over the entire range of *Solidago glutinosa* and *S. simplex* as shown in Fig. 5. In his multivariate morphometric study of sect. *Humiles* as it was known at the time, Ringius (1985) did not include specimens from Mexico and treated the western plants as *S. glutinosa* subsp. *glutinosa* and *S. spathulata*. Observations on specimens of *S. simplex* from Mexico borrowed from GH, MO, LL, and TEX (Thiers, continuously updated) led to the decision that a multivariate study of Mexican *S. simplex* should be undertaken to compare the Mexican plants with samples of *S. glutinosa* and *S. spathulata* of subsect. *Humiles* and *S. multiradiata* Ait. and *S. leiocarpa* of subsect. *Multiradiatae* Semple (Fig. 8), due to some similarities of some of the samples of *S. simplex* from Mexico to both *S. multiradiata* and *S. glutinosa*. The results of the multivariate analysis are presented below.

MATERIALS AND METHODS

In total, 80 specimens selected from a much larger number of specimens from GH, J.K.Morton in ROM, K, LL, MO, TEX, and WAT in MT (Thiers, continuously updated) were scored and included in this study. Data was scored on *Solidago glutinosa* (27 specimens), *S. simplex* (11 specimens), and *S. spathulata* (12 specimens) of subsect. *Humiles* and *S. leiocarpa* (13 specimens) and *S. multiradiata* (17 specimens) of subsect. *Multiradiatae*. Nineteen vegetative and 19 floral traits were scored when possible: 1-5 replicates per character depending upon availability of material and whether or not the trait was meristic (Table 1). Mean values were used in the analyses, while raw values were used to generate ranges of variation for each trait.

Traits used to define a priori groups were not included in the analyses to avoid circular logic. Differences in general inflorescence shape and branching characteristics were used to define a priori

Figure 6. Examples of *Solidago leiocarpa* used in the multivariate study: **A.** *Ringius 1557* (WAT). **B.** Upper stem and leaf, *Ringius 1586* (WAT). **C.** Lower portion of inflorescence, *Ringius 1557* (WAT). Scale bar = 1 cm in B; = 1 mm in C.

Figure 7. Examples of *Solidago multiradiata* used in the multivariate study: **A.** *Chmielewski et al. CC4753* (WAT). **B.** Head, *Clements s.n.* (WAT). **C.** Upper stem leaf, *Semple et al. 11165* (WAT). **D.** Peduncle, bracts, and phyllaries, *Fraser 113* (WAT). Scale bar = 1 cm in C; = mm in A, B, and D.

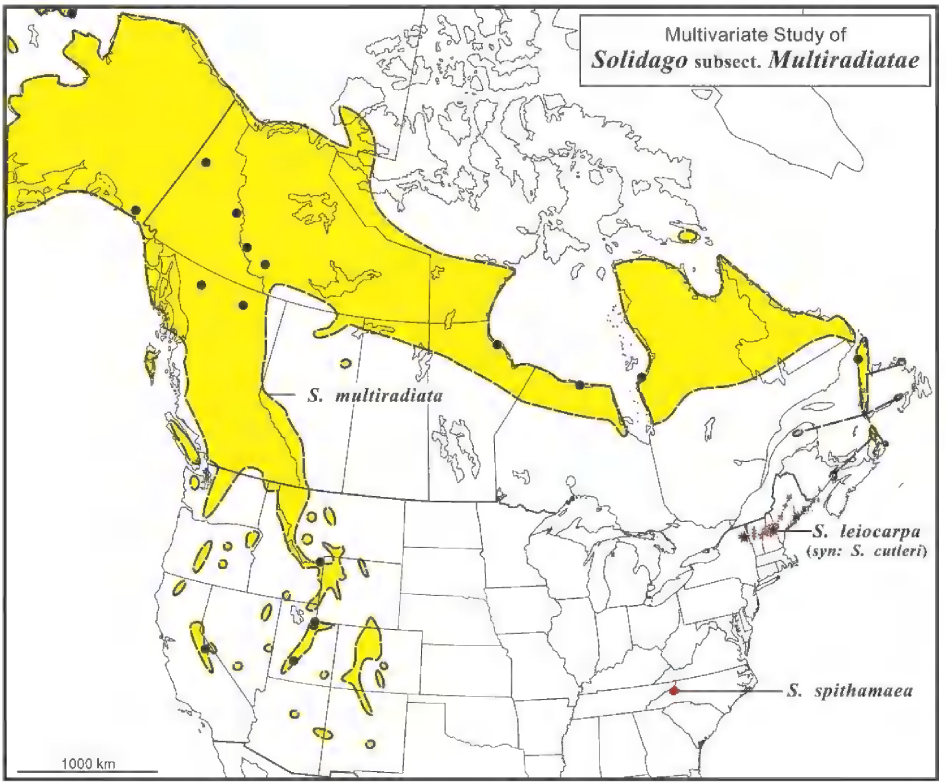

Figure 8. Distribution of the ranges and locations of multivariate samples of *Solidago leiocarpa* (stars) and *S. multiradiata* (black dots) of *Solidago* subsect. *Multiradiatae*. *S. spithamaea* was not included in the study.

groups along with phyllary shape and geographic location. Basal rosettes were not included in the analyses because these were often not present on specimens. Lower stem leaves were also not included because they were not always present.

All analyses were performed using SYSTAT v.10 (SPSS 2000). Details on the methodology are presented in Semple et al. (2016) and are not repeated here. Four analyses were performed. In the first analysis, five putative species level a priori groups were included: *S. glutinosa*, *S. leiocarpa*, *S. multiradiata*, *S. simplex*, and *S. spathulata*. In the second analysis, three species level a priori groups were included: *S. glutinosa*, *S. multiradiata*, and *S. simplex*. In the third analysis only *S. multiradiata* and *S. simplex* were included. In the fourth analysis only *S. glutinosa* and *S. simplex* were included.

RESULTS

Five species groups analysis

Two analyses including five species level a priori groups were run. The analysis including disc florets had slightly higher F-to separate values than the analysis including ray florets and the only the first of the two analyses is presented.

Table 1. Traits scored for the multivariate analyses of specimens of *Solidago glutinosa*, *S. leiocarpa*, *S. multiradiata*, *S. simplex*, and *S. spathulata*.

Abbreviation	Description of trait scored
STEMHT	Stem height measured from the stem base to tip(cm)
UPSTMNOD25	Number of nodes in distal 25% of the stem below the inflorescence
UPSTMNOD 20	Number of nodes in distal 20% of the stem below the inflorescence
BLFLN	Basal rosette leaf length measured from the leaf base to tip (mm)
BLFWD	Basal rosette leaf width measured at the widest point (mm)
BLFWTOE	Basal rosette leaf measured from the widest point to the end (mm)
BLFSER	Basal rosette leaf dentation - number of serrations along (one side)
LLFLN	Lower leaf length measured from the leaf base to tip (mm)
LLFWD	Lower leaf width measured at the widest point (mm)
LLFWTOE	Lower leaf measured from the widest point to the end (mm)
LLFSER	Lower leaf margin - number of serrations (one side)
MLFLN	Mid leaf length measured from the leaf base to tip (mm)
MLFWD	Mid leaf width measured at the widest point (mm)
MLFWTOE	Mid leaf measured from the widest point to the end (mm)
MLFSER	Mid leaf margin - number of serrations (one side)
ULFLN	Upper leaf length measured form the leaf base to tip(mm)
ULFWD	Upper leaf width measured at the widest point (mm)
ULFWTOE	Upper leaf measured from the widest point to the end (mm)
ULFSER	Upper leaf margin - number of serrations (one side)
CAPL	Length of inflorescence (cm)
CAPW	Width of inflorescence (cm)
CAPBRLN	Length of longest lower inflorescence branches (cm)
INVOLHT	Involucre height (mm)
OPHYLN	Outer phyllary length (mm)
OPHYLW	Outer phyllary width (mm)
IPHYLN	Inner phyllary length (mm)
IPHYLW	Inner phyllary width (mm)
RAYNUM	Number of ray florets per head
RSTRAPLN	Ray strap length top of the corolla tube to the tip of the strap (mm)
RSTRAPWD	Ray strap width measured at the widest point (mm)
RACHLN	Ray floret cypsela body length at anthesis (mm)
RPAPLN	Ray floret pappus length at anthesis (mm)
RPUB	Density of hairs on ray floret ovary at anthesis (1-5 scale)
DCORLN	Disc corolla length from the base to tip of the corolla lobes (mm)
DLOBLN	Disc corolla lobe length lobe (mm)
DACHLN	Disc achene length (mm)
DPAPLN	Disc pappus length (mm)
DPUB	Density of hairs on disc floret ovary at anthesis (1-5 scale)

In the STEPWISE discriminant analysis including of 80 specimens of five species level a priori groups (*Solidago glutinosa*, *S. leiocarpa*, *S. multiradiata*, *S. simplex*, and *S. spathulata*), the following six traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of mid margin serrations (42.16), involucre height (39.48), ray floret lamina length (21.11), number of disc florets (9.32), mid leaf length (8.32), and upper stem leaf width (8.18). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 2. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *Solidago multiradiata* and *S. spathulata* (47.915); the smallest separation was between *S. glutinosa* and *S. simplex* (3.851).

Table 2. Between groups F-matrix for the five a priori group analysis (df = 6 70).

Group	*glutinosa*	*leiocarpa*	*multiradiata*	*simplex*
leiocarpa	33.307			
multiradiata	29.628	32.678		
simplex	3.851	16.495	10.034	
spathulata	25.698	25.724	47.915	23.394

Wilks' lambda = 0.0195 df = 6 4 75; Approx. F = 21.3413 df = 24 245 prob = 0.0000

In the Classificatory Discriminant Analysis of the five species level a priori groups, percents of correct a posterori assignment to the same a priori group ranged from 100% down to 81%. The Classification matrix and Jackknife classification matrix are presented in Table 3. Results are presented in order of decreasing percents of correct placement. All 17 specimens of *Solidago multiradiata* (100%) were assigned a posteriori into the *S. multiradiata* group; 13 specimens with 90-100% probability; 2 specimens with 82-89%% probability; 1 specimen with 55% probability (43% to *S. simplex* and 2% to *S. glutinosa*, and 1 specimen with 52% probability (43% to *S. simplex* and 6% to *S. glutinosa*). All 12 of the specimens of the *S. spathulata* a priori group (100%) were assigned a posteriori to the *S. spathulata* group: 11 specimens with 99-100% probability and 1 specimen with 63% probability (34% to *S. glutinosa*). Twelve of the 13 specimens of the *S. leiocarpa* a priori group (92%) were assigned a posteriori to the *S. leiocarpa* group: 11 specimens with 100% probability and 1 specimen with 89% probability (9% to *S. simplex* and 2% to *S. glutinosa*). One specimen of the *S. leiocarpa* a priori group was assigned to *S. simplex* with 90% probability (10% to *S. glutinosa*). Nine of the 11 specimens of the *S. simplex* a priori group (82%) were assigned a posteriori to the *S. simplex* group: 1 specimen with 91% probability, 4 specimens with 80-87% probability, 1 specimen with 77% probability (22% to *S.*

Table 3. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of five a priori groups; a posteriori placements to groups in rows.

Group	*glutinosa*	*leiocarpa*	*multiradiata*	*simplex*	*spathulata*	% correct
glutinosa	22	0	0	5	0	81
leiocarpa	0	12	0	1	0	92
multiradiata	0	0	17	0	0	100
simplex	2	0	0	9	0	82
spathulata	0	0	0	0	12	100
Totals	24	12	17	15	12	90

Jackknife Classification Matrix

Group	*glutinosa*	*leiocarpa*	*multiradiata*	*simplex*	*spathulata*	% correct
glutinosa	21	0	0	6	0	78
leiocarpa	0	12	0	1	0	92
multiradiata	0	0	15	2	0	88
simplex	2	0	1	8	0	73
spathulata	1	0	0	0	11	92
Totals	24	12	16	17	11	84

glutinosa), 1 specimen with 60% probability (26% to *S. glutinosa* and 14% to *S. multiradiata*), and 1 specimen with 58% probability (40% to *S. multiradiata* and 2% to *S. glutinosa*). Two specimens of the *S. leiocarpa* a priori group with assigned to *S. glutinosa*: 1 specimen 87% probability (13% to *S. simplex*) and 1 specimen with 58% probability (42% to *S. leiocarpa*). Twenty-two of the 27 specimens of the *S. glutinosa* a priori group (81%) were assigned a posteriori to the *S. glutinosa* group: 9 specimens with 90-99% probability, 6 specimens with 81-89% probability, 1 specimen with 74% probability (26% to *S. simplex*), 4 specimens with 61-67% probability (39-26% probability to *S. simplex*), and 2 specimens with 54% and 56% probabilities (46% and 41% to *S. simplex*, respectively). Five specimens of the *S. glutinosaa* a priori group with assigned to *S. simplex*: 1 specimen with 71% probability (27% to *S. glutinosa*), 3 specimens to 60-69% probability (40-30% to *S. glutinosa*), and 1 specimen with 49% probability (30% to *S. glutinosa* and 21% to *S. multiradiata*).

Two dimensional plots of CAN1 versus CAN 3 and CAN1 versus CAN2 canonical scores for 80 specimens of *S. glutinosa*, *S. leiocarpa*, *S. multiradiata*, *S. simplex*, and *S. spathulata* are presented in Fig. 9. Eigenvalues on the first three axes were 4.354, 2.855 and 0.082.

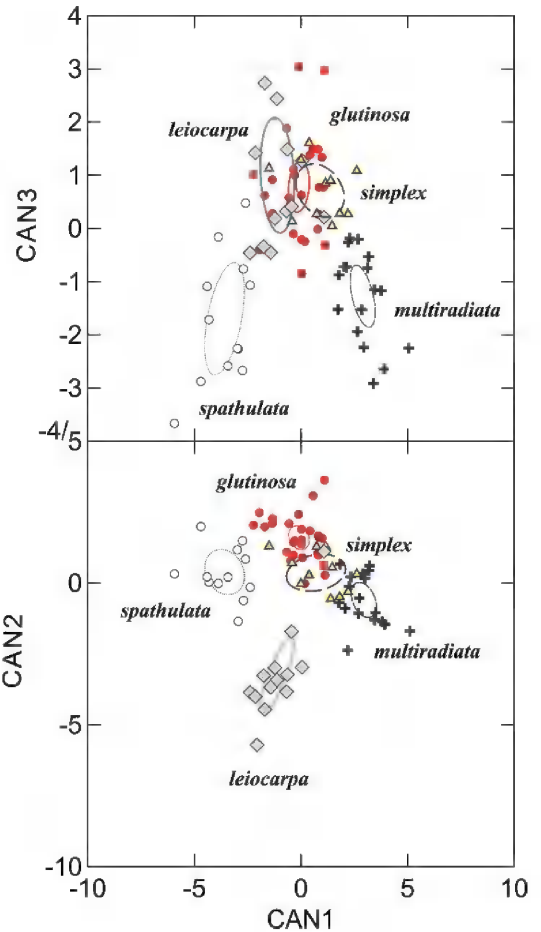

Figure 9. Two dimension plots of CAN1 versus CAN2 and CAN1 versus CAN3 scores for 80 specimens of five a priori groups of *Solidago* subect. *Humiles* and *S.* subsect. *Multiradiatae*: *S. glutinosa* (red dots), *S. leiocarpa* (gray diamonds), *S. multiradiata* (black +s), *S. simplex* (yellow triangles), and *S. spathulata* (white dots).

Three species groups analysis

In the STEPWISE discriminant analysis of 55 specimens of three species level a priori groups (*Solidago glutinosa*, *S. multiradiata*, and *S. simplex*), the following five traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: upper stem leaf width (9.62), number of disc florets (8.76), disc floret pappus length at anthesis (4.88), number of mid stem leaf margin serrations (4.86), and mid stem leaf length (4.72). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. The F-matrix for the discriminant analysis is presented in Table 4. F-values based on Mahalanobis distances of the between group centroids indicated the largest separation was between *S. glutinosa* and *S. multiradiata* (19.039), and the smallest separation was between *S. multiradiata* and *S. simplex* (4.124) and only slightly larger between *S. glutinosa* and *S. simplex* (4.593).

Table 4. Between groups F-matrix for the three a priori group analysis (df = 5 48).

Group	*glutinosa*	*multiradiata*
multiradiata	19.039	
simplex	4.593	4.124

Wilks' lambda = 0.2940 df = 5 2 52; Approx. F= 8.1054 df = 10 96 prob = 0.0000

In the Classificatory Discriminant Analysis of the three species level a priori groups, the percents of correct placement a posteriori ranged from 55-78%. The Classification matrix and Jackknife classification matrix are presented in Table 5. Twenty of 27 specimens of *Solidago glutinosa* (78%) were assigned a posteriori to the *S. glutinosa* group; 7 specimens with 91-100% probability, 7 specimens with 80-89% probability, 2 specimens with 73% and 79% probabilities, 4 specimens with 60-68% probability (24-36% to *S. simplex* and 4-8% to *S. multiradiata*), and 1 specimen with 54% probability (46% to *S. simplex*). Six specimens of the *S. glutinosa* a priori group were assigned to *S. simplex* with 54-58% (31-49% to *s. glutinosa* and 1-5% to *s. multiradiata*). Thirteen of the 17 specimens of the *S. multiradiata* a priori group (76%) were assigned a posteriori into the *S. multiradiata* group; 7 specimens with 93-100% probability, 1 specimen with 86% probability, 1 with 79% probability, 2 with 63% and 66% probabilities (37% and 33% probabilities to *S. simplex*), and 2 specimens with 51% and 53% probabilities (37% and 35% probabilities to *S. simplex* and 14% and 10% to *S. glutinosa*). Four specimens of the *S. multiradiata* a priori group were assigned to the other two species: 3 specimens with 61%, 59% and 49% to *S. simplex* (27%, 37% and 43% to *S. multiradiata* and 12%, 3% and 8% to *S. glutinosa*, respectively). Six of 11 specimens of the *S. simplex* a priori group (55%) were assigned a posteriori to *S. simplex*: 2 specimens with 82-84% probability, 1 specimen with 71% probability (26% to *S. glutinosa*), 1 specimen with 64% probability (29% to *S. multiradiata* and 7% to *S. glutinosa*), and 2 specimens with 48% probability (1 with 48% to *S. multiradiata* and 1 with 46% to *S. glutinosa*). Five specimens of the *S. simplex* a priori group were assigned a posteriori into other species: 3 specimen was assigned to *S. multiradiata* with 65%, 52% and 50% probabilities (34%, 47% and 48% probabilities to *S. multiradiata*) and 2 specimens with 87% and 64% probabilities to *S. glutinosa* (13% and 33% to *S. simplex*).

Two dimensional plot of CAN1 versus CAN2 canonical scores for 55 specimens of *Solidago glutinosa*, *S. multiradiata*, and *S. simplex* are presented in Fig. 10. Eigenvalues on the first two axes were 2.003 and 0.133.

Two species groups analysis I

In the STEPWISE discriminant analysis of 28 specimens of *Solidago multiradiata* and *S. simplex*, the following four traits were selected in a STEPWISE analysis and are listed in order of decreasing F-to-

Table 5. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of three a priori groups; a posteriori placements to groups in rows.

Group	*glutinosa*	*multiradiata*	*simplex*	% correct
glutinosa	21	0	6	78
multiradiata	1	13	3	76
simplex	2	3	6	55
Totals	24	16	15	73

Jackknifed classification matrix

Group	*glutinosa*	*multiradiata*	*simplex*	% correct
glutinosa	20	0	7	74
multiradiata	1	12	4	71
simplex	3	4	4	36
Totals	24	16	15	65

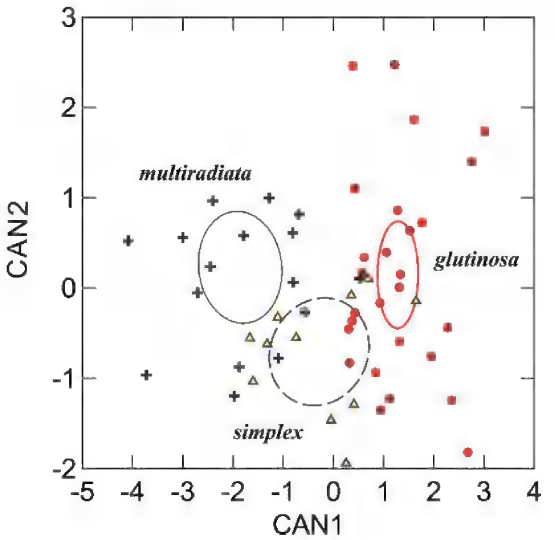

Figure 10. Two dimension plot of CAN1 versus CAN2 scores for 55 specimens in three a priori: *S. glutinosa* (red dots), *S. multiradiata* (black +s), and *S. simplex* (yellow diamonds).

remove values: disc floret corolla length (20.50), mid stem leaf length (11.30), number of ray florets (9.21), and mid stem leaf width (7.88). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. Group centroids of *Solidago multiradiata* and *S. simplex* had an F-to separate value of 11.553 (Wilks' lambda = 0.3323, df = 4 1 26; Approx. F= 11.5527, df = 4 23, prob = 0.0000).

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori groups were 100% for *S. simplex* and 82% for *S. mutliradiata.* The Classification matrix and Jackknife classification matrix are presented in Table

6. All 11 specimens included in the *S. simplex* a priori group (100%) were assigned a posteriori to that species: 9 specimens with 92-100% probability; 1 specimen with 85% probability (*Pringle 79*10 GH from 9800 ft. {= 2987 m}, Sierra de Pachuca, Hidalgo, Mexico; large basal rosette leaves, slightly resinous leaves and phyllaries), and 1 specimen with 84% probability (*Pringle 10294* GH from 9500 ft. {= 2895 m} Sierra de Pachuca, Hidalgo, Mexico; large basal rosette leaves, slightly resinous leaves, and thickly resinous phyllaries). Sixteen of the 17 specimens of *S. multiradiata* a priori group (94%) were assigned a posteriori to the *S. multiradiata* group: 12 specimens with 92-100% probability; 1 specimen with 84% probability, 1 specimen with 71% probability, 1 specimen with 53% probability (*Morton & Venn NA12401* WAT from the Northern Peninsula, Newfoundland), and 50% probability (Hawthorn s.n. WAT from Churchill, Manitoba). One specimen of the *S. multiradiata* a priori group was assigned a posteriori to *S. simplex* with 50% probability; *Kharkevich & Buck 836* K from Chukotka A.O. of extreme eastern Russia; the specimen includes three short shoots each with a small, few-headed inflorescence, upper stem leaves with long-haired ciliate margins, and subequal non-resinous very narrow triangular attenuate phyllaries that at typical for the *S. multiradiata*.

Frequencies of CAN1 canonical scores for 28 specimens of *Solidago multiradiata* and *S. simplex* are presented in histograms in Fig. 11. The Eigenvalue on the first axis was 2.009.

Table 6. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of two a priori groups; a posteriori placements to groups in rows.

Group	*multiradiata*	*simplex*	% correct
multiradiata	16	1	94
simplex	0	11	100
Totals	16	12	96

Jackknifed classification matrix

Group	*multiradiata*	*simplex*	% correct
multiradiata	14	3	82
simplex	0	11	100
Totals	14	14	89

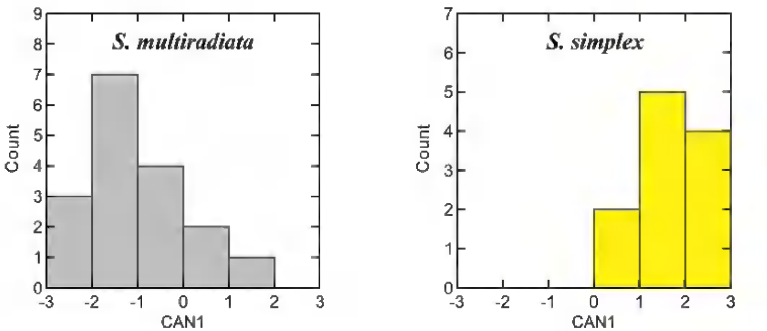

Figure. 11. Histograms of CAN1 canonical scores for 28 specimens of *S. multiradiata* (left) and *S. simplex* (right).

Two species groups analysis II

In the STEPWISE discriminant analysis of 38 specimens of *Solidago glutinosa* and *S. simplex*, the following four traits selected in a STEPWISE analysis are listed in order of decreasing F-to-remove values: number of disc florets (17.06), disc floret corolla length (12.07), width of the inflorescence (11.35), disc corolla lobe length (4.97). Wilks's lambda, Pillai's trace, and Lawley-Hotelling trace tests of the null hypothesis that all groups were the samples of one group had probabilities of p = 0.000 that the null hypothesis was true. *Solidago glutinosa* and *S. simplex* had an F-to separate value of 10.624 (Wilks' lambda = 10.6240, df = 4 33; prob = 0.0000).

In the Classificatory Discriminant Analysis of the two species level a priori groups, the percents of correct placement a posteriori of specimens to the a priori group were 93% for *Solidago glutinosa* and 82% for *S. simplex*. The Classification matrix and Jackknife classification matrix are presented in Table 7. Twenty-five of the 27 specimens of *S. glutinosa* (93%) were assigned a posteriori to *S. glutinosa*: 18 specimens with 90-100% probability, 4 with 81-87% probability, 1 with 77% probability, and 1 with 63% probability. Two specimens of the *S. glutinosa* a priori group were assigned to *S simplex* with 60% probability (*Morton & Venn NA14134* JKM in ROM from Muncho L. Provincial Park, British Columbia; long narrow inflorescence with short hairs and heads with narrow phyllaries) and 55% probability (*Ringius 1976* WAT from Terrace Bay, Thunder Bay Dist., Ontario on coastal rocks of Lake Superior; short plants with small inflorescence with a few short hairs, heads with narrow resinous phyllaries). Nine of the 11 specimens of *S. simplex* (82%) were assigned a posteriori to the *S. simplex* group: 5 with 98-100% probability, 2 with 89% and 83% probabilities, 1 with 73% probability, and 1 with 62% probability. Two specimens of the *S. simplex* a priori group were assigned a posteriori to *S. glutinosa*: 1 with 95% (*Roe, Roe, & Mori 247* LL from NE of Jacala, Hidalgo, Mexico; inflorescence branches elongated, heads small, phyllaries narrow for *S. simplex*; cypselae glabrous with thickened brownish-red translucent ribs) and 1 specimen with 66% probability (*Stanford, Taylor & Lauber 2552* TEX from Cerro Pena Nevada, Tamaulipas, Mexico; short stems with small inflorescences with immature lower branches, hairs on main stem of inflorescence moderately dense to 0.3 mm long, somewhat villose, phyllaries broad).

Frequencies of CAN1 canonical scores for specimens of *S. glutinosa* and *S. simplex* are presented in histograms in Fig. 12. The eigen value on the first axis was 1.288.

Table 7. Linear and jackknife classification matrices from the Classificatory Discriminant Analysis of two a priori groups; a posteriori placements to groups in rows.

Group	*glutinosa*	*simplex*	% correct
glutinosa	25	2	93
simplex	2	9	82
Totals	27	11	89

Jackknifed classification matrix

Group	*glutinosa*	*simplex*	% correct
glutinosa	25	2	93
simplex	3	8	73
Totals	28	10	87

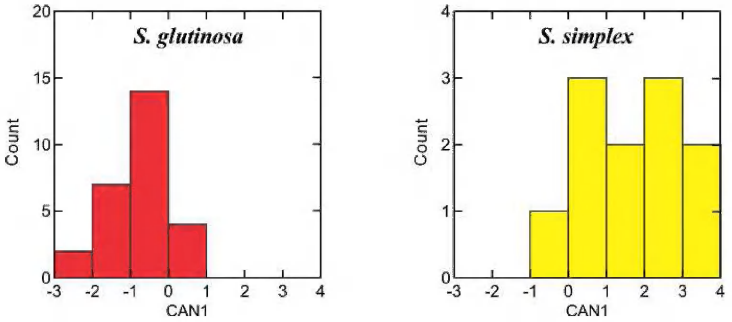

Figure. 12. Histograms of CAN1 canonical scores for 38 specimens of *S. glutinosa* (left) and *S. simplex* (right).

DISCUSSION

Based on the results of the multivariate analyses and additional observations on morphology the following taxa should be recognized as species: *Solidago glutinosa*, *S. simplex,* and *S. spathulata* in subsect. *Humiles* and *S. leiocarpa* and *S. multiradiata* in subsect. *Multiradiatae*. *Solidago glutinosa* should be treated as separate from *S. simplex* on the basis of the results of the multivariate analyses, its short branched elongated inflorescence versus the longer branched inflorescence of *S. simplex,* its short hairs (0.1-2 mm long) on the mid to upper stem and in the inflorescence, its usually narrower phyllaries, and its generally more densely short-haired cypselae. The ranges of *S. glutinosa* and *S. simplex* are separated by some 1000 km between the southernmost populations of *S. glutinosa* in New Mexico and the northern most populations of *S. simplex* in Nuevo León, Mexico. In the multivariate analyses, some specimens of *S. simplex* showed stronger similarities to *S. multiradiata* than to *S. glutinosa* confirming the first author's impression that some *S. simplex* specimens had features approaching those of *S multiradiata*.

In the intuitive phylogeny of *Solidago*, Semple (2016) did not separate *S. glutinosa* from *S. simplex* in the subsect. *Humiles* portion of the diagram; the branch labeled "*S. simplex*" is the *S. glutinosa* branch. *Solidago simplex* may be the most basal species in subsect. *Humiles* and a new branch for *S. simplex* can be added to the diagram lower down on the branch leading to other taxa in the subsection. *Solidago simplex* has phyllaries with rounded or obtuse ends like other species in subsect. *Humiles* and the leaves and phyllaries are somewhat to obviously resinous like other taxa in subsect. *Humiles*. In his cpDNA RFLP phylogenetic analyses, Zhang (1996) determined that *S. glutinosa* (as *S. simplex*), *S. multiradiata*, and *S. virgaurea* formed a clade, which is reflected in Semple (2016). Thus, it should not be surprising that there are morphological similarities between species of subsect. *Humiles*, subsect. *Multiradiatae*, and (across Eurasia) subsect. *Solidago*. *Solidago glutinosa* and *S. multiradiata* are both western cordilleran taxa that probably evolved from an ancestral taxon native to the mountains of eastern Mexico. *Solidago simplex* is the only species in either subsection still native to the mountains of eastern Mexico.

Solidago spathulata is the most densely resinous species in subsect. *Humiles* and has numerous serrations on lower and mid stem leaves and often on upper stem leaves. The numbers of leaf serrations accounts for the strong separation of *S. spathulata* from the other four species in the canonical analysis diagrams in Fig. 9. It is restricted to coastal sand dunes and headlands along the Pacific Ocean in Oregon and California (Fig. 5).

Solidago leiocarpa was strongly separated from the other four species on the CAN1 and CAN2 axes of the diagram in Fig. 9 with the exception of one specimen being more *S. simplex*-like. *Solidago leiocarpa* is native to higher elevations in the mountains of northeastern New York, north-central New Hampshire, and Maine in exposed alpine boulder plains, rock crevices, and alpine lawns, i.e. tundra like habitats. Tetraploid *S. leiocarpa* is likely a derivative of *S. multiradiata* that diverged in isolation as glaciers retreated northward in eastern North America.

All specimens of *Solidago multiradiata* were assigned a posteriori to that species in the five species analysis. Only two specimens were assigned with low percents of probability. However, in the plots of canonical scores diagram (Fig. 9), specimens of *S. multiradiata* did not separate out strongly from specimens of *S. simplex* in the first and second canonical axes, but they did separate out on the third axis. In the canonical scores diagram of *S. glutinosa*, *S. multiradiata*, and *S. simplex* (Fig. 10), symbols for *S. multiradata* and *S. simplex* are not fully separated. The ranges of distribution of *S. multiradiata* and *S. simplex* are separated by some 1000 km. The ranges of distribution of *S. multiradiata* and *S. glutinosa* are sympatric over much of the western range, with *S. multiradiata* occurring at higher elevations than *S. glutinosa*. In locations where the two ranges come into contact, the two species came be difficult to distinguish because both can be short and have small inflorescences. Differences in phyllary shape and size of the outer phyllaries usually is sufficient to allow relative ease in identification: *S. multiradiata* (Fig. 7B) and *S. glutinosa* (Fig. 3B). However, the two species appear to hybridize sometimes, when both occur together as diploids, as in the Colorado Front Range. Specimens of *S. multiradiata* have been misidentified as *S. simplex*, *S. glutinosa*, *S. randii*, and *S. racemosa* in different parts of the range of *S. multiradiata* across Canada. Species of subsect. *Humiles* never have phyllaries like those of *S. multiradiata*, whereas species of subsect. *Solidago* across Eurasia sometimes do have similar phyllaries to those of *S. multiradiata*.

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